

MORPHOLOGICAL AND BIOLOGICAL NOTES ON  
SOME SOUTH AFRICAN ARTHROPODS  
ASSOCIATED WITH DECAYING ORGANIC MATTER

PART 1

CHILOPODA, DIPLOPODA, ARACHNIDA, CRUSTACEA,  
AND INSECTA

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(With 17 figures and 2 tables)

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ABSTRACT

Arthropods found in association with leaf litter and other decaying matter were collected for forensic purposes in a narrow strip along the south and west coasts. Twenty-one species in nine orders are discussed in some detail and information is given regarding their morphology, biology, and ecology. Most of these arthropods play an important role in the breakdown of organic matter, others are merely predators, which are mainly discussed here.

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## GENERAL INTRODUCTION

Intensive studies have been conducted in the past in the field of medical and veterinary entomology; however, forensic research has been neglected by entomologists and our knowledge on this subject is therefore very limited. The few facts that are known are usually included as a chapter in occasional major works on forensic medicine. The most comprehensive data for South African entomologists are probably various paragraphs in *Medical Jurisprudence* (Gordon, Turner & Price 1953) and an article on flies on human faeces and carcasses (Zumpt & Patterson 1952).

Following requests by the police and State Health Department regarding cases of murder and cattle theft, the author undertook research to obtain a better knowledge of the arthropod successions related to decaying cadavers and thereby to provide additional evidence in cases presenting problems in judicial examinations.

In an investigation of this nature two aspects have to be considered, first, a survey of the various arthropod populations associated with decaying organic

matter in a certain area, most of which may be indirectly involved, and second, an assessment of those directly responsible for the destruction of cadavers and carcasses.

As part of a survey of insects that may be involved in forensic entomology, a preliminary study was conducted during 1976 to 1979 on the arthropods associated with organic matter. Large numbers of arthropods were collected along a narrow strip of the southern and western coastal regions of South Africa, on the beach, the dune system, and some 20–30 km inland. A small strip between Laingsburg and Beaufort West and another between Worcester and Tulbagh were also included.

As the immature stages of the vast majority of these arthropods are still unknown, an attempt was made to rear the various species either in their natural breeding media or in suitable substitutes in order to obtain information on their life cycles. The condition and colour of the specimens were noted before preservation in 80 per cent alcohol and drawings were made with the aid of a camera lucida. The average monthly temperature in the laboratory was recorded throughout the observation periods (Fig. 1A–D). The morphological terms used in this series of papers in the descriptions of the various instars are those of Greene (1922), Böving & Craighead (1931), and Hennig (1968), unless otherwise stated. Identification of the specimens was made by reference to material in the collection of the South African Museum or as verified by specialists in various other institutions.

The first part of this series includes centipedes, spiders, scorpions, ticks and mites, mantids, earwigs, flower-bugs and assassin-bugs, which are all predacious except for ticks and certain mites. It also includes millepedes, sow-bugs, beach-fleas, cockroaches, crickets, red-bugs, chinch-bugs and shield-bugs, which are mostly phytophagous or are in some or other way associated with decaying organic matter. These arthropods are really of minor importance to the forensic entomologist but may play a role either as predators or in breaking down organic material in the soil. Some species such as the chinch-bugs, red-bugs and shield-bugs are mainly phytophagous, but they were often found in leaf litter or accumulations of debris and have therefore been included.

The terrestrial arthropods of a particular region are dependent in most cases directly or indirectly on the floral elements of that region. The coast, with its marine, animal and plant detritus, and unique flora of its adjacent dunes in general, has a very different arthropod fauna from the inland areas.

The beaches along the south and west coasts that were surveyed are usually separated from the interior by a sand-dune biotope which is characterized by the presence of a fairly large variety of plants of which the 'kinkelbossies', *Tetragonium decumbens* and *T. fruticosum*, as well as *Arctotheca populifolia*, *Heteroptilis suffruticosa*, *Matricaria sabulosa*, *Mesembryanthemum crystallinum*, and *Limonium perigrinum* are mostly found on the small fore-dunes. Various other plants such as *Ruppia*, *Zostera*, *Phragmites* and *Spartina* spp. are to be found along the river-banks and in estuaries. Grasses including *Agropyron distichum*, *Sporo-*

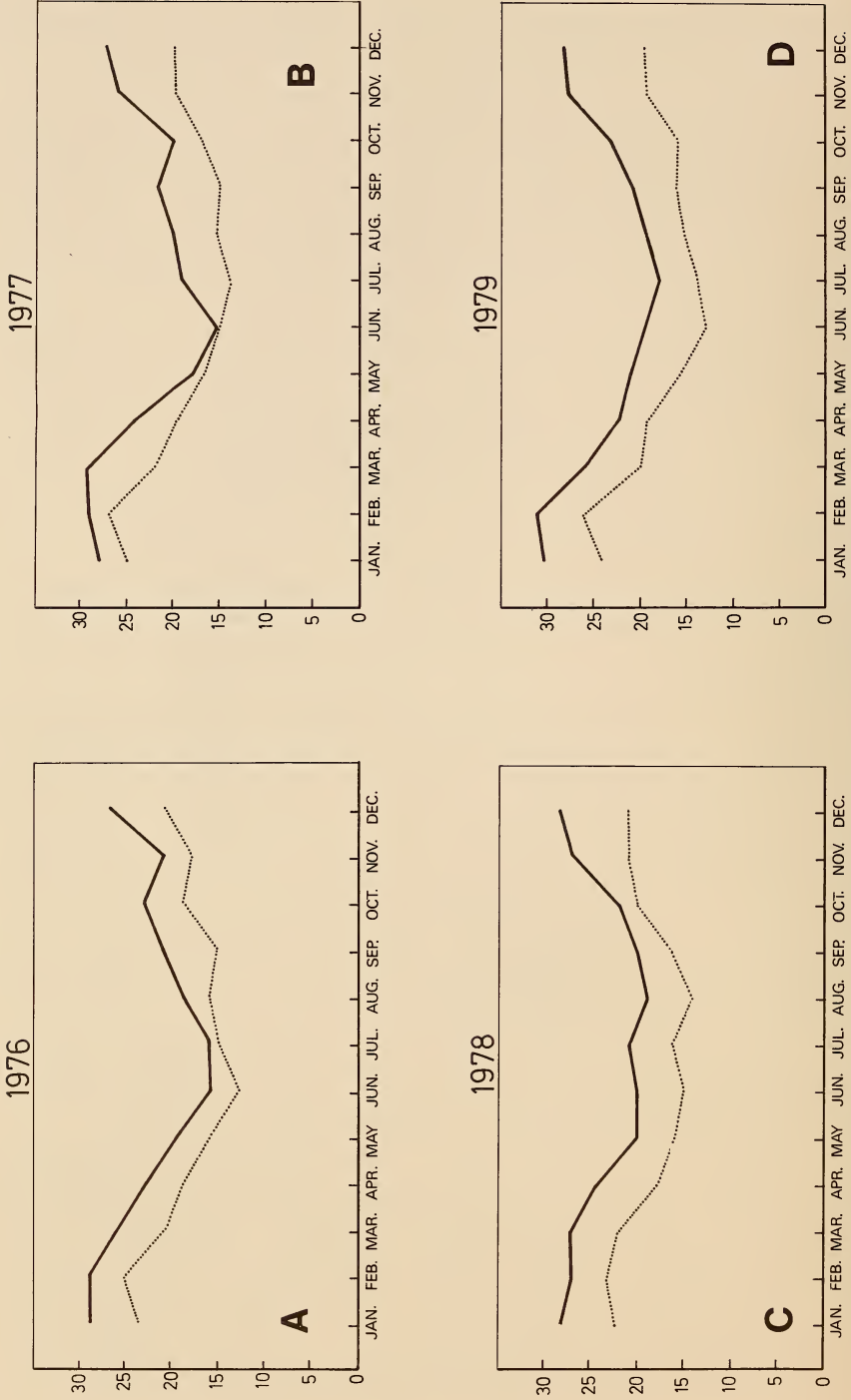


Fig. 1. A-D. Average monthly maximum and minimum temperatures (in degrees Celsius) in laboratory for 1976-9.

*bolus virginicus*, and *Eragrostis spinosa* frequently grow on the beaches, even reaching the intertidal zone in some areas, and along the Cape south coast *Osteospermum fruticosum* and *Polygala mystifolia* often reach the shingle-covered parts of the beach above the highwater mark.

On the beach itself there are mainly brown and green seaweeds such as *Ecklonia maxima* and *Laminaria pallida*, and very often also the dead bodies of marine animals and birds. In some areas along the south and south-east coast the large kelps are entirely absent and the beaches are usually completely barren and devoid of any seaweed, which results in a sparse arthropod fauna. Further west, however, the number of plants washed up by wave action increases and provides an excellent habitat for a large variety of arthropods.

Various factors will influence the properties of the wrack arthropod communities and man as an extra-biotope agent cannot be excluded, particularly in areas where commercial collection of kelp occurs as some eucoenic species can exist only in large banks of kelp (Backlund 1945). In certain parts along the west coast where kelp is collected for commercial purposes, some of the species normally present were not found during the surveys.

Three types of wrack are generally recognized, wrack strings, wrack flakes, and wrack banks (Backlund 1945; Egglisshaw 1960). The banks are the most important as they provide the main source of food for the various species of the shore fauna.

Continuous exposure of the marine rejectamenta to sprays and wind-borne moisture from the sea affects the composition of the arthropod communities and there is therefore a marked difference between the amnicolous and thincolous associations and the fauna of the greater interior. Although the maritime species of arthropods exhibit a far greater tolerance to salt than those living further away from the sea, there is an overlap of the various species along the coast, especially among certain Coleoptera, Diptera and Lepidoptera. On the other hand, the vast interior with its variable ecosystems and very large floristic potential presents a wide range of biotopes supporting a comparatively large invertebrate fauna, and a greater number of arthropod species will therefore attack decaying and dry organic matter.

## ECOLOGICAL AND BIOLOGICAL NOTES

### CLASS CHILOPODA

Usually active, nocturnal predators with dorsoventrally flattened or depressed bodies. Only one pair of legs on each body segment; first pair modified into poison claws. Ocelli may be present.

Various centipedes were found to be associated with decaying matter, and these include the rather small species of the genus *Lamyctes* with only fifteen pairs of legs and the very elongate, worm-like species of *Eurytion* such as *E. dolichocephalus* Attems, which is pale reddish in colour, measures up to 60 mm in length and has nearly eighty pairs of legs. The latter species was collected in all

the areas surveyed and was often found deeply imbedded in semi-dry dung during the winter. Cast skins have often been found together with medium-sized specimens. From collection records it seems to be endemic to the Cape, having been found along the west and south coasts and inland as far as De Aar and Hanover. However, further collections may prove otherwise.

Of the Scolopendromorpha, at least two species appeared to be fairly common under semi-fresh to almost dry cow-pats wherever collections were made. The one, a bluish-coloured *Cormocephalus* species (about 50 mm long, and its larvae), occurred at Hermanus and Stilbaai during the winter; it is apparently the same species that was collected near Philadelphia during the same period. In the western and north-western parts, particularly in the coastal areas of Namaqualand, a large proportion of the pats contained the bluish-green *Arthrorhabdus formosus* Pocock, most of which were about 45 mm long with a broad, brownish-red, longitudinal stripe over the dorsum. Specimens from Saldanha, on the other hand, were more reddish in colour and the mid-dorsal stripe was greenish. This centipede is very similar to *Cormocephalus* species, but is easily distinguished by the spines on the tarsi (absent in *Cormocephalus* species) and by the posterior margin of the head plate, which is free (covered by the first body segment in *Cormocephalus* species). Prey of both species included spiders, cockroaches, and silver-fish.

The introduced house centipede, *Scutigera coleoptrata* (Linnaeus), with its long slender legs, often appeared at carcasses in various parts of the Cape Peninsula during the later post-mortem stage of decay where it mainly devoured some of the members of the fly population. It is widely distributed in the western, southern, and eastern Cape and in Natal.

#### ORDER LITHOBIOMORPHA

##### Family Henicopidae

##### *Lamyctes castanea* Attems

Adult centipede small, brownish red to reddish, 10–12 mm long. Head somewhat darker in colour with one ocellus on each side. Fifteen pairs of legs, tibia of twelfth pair not toothed. Posterior angles of all tergites rounded, not dentate (Fig. 2A–B).

The species seems to be endemic to the Cape Province and is commonly found under semi-fresh to almost dry cow-pats both inland and on the beach, often in association with *L. africana* Porat; it regularly visits carcasses and corpses to feed on the small soft-bodied insects attracted to the decaying material. Both *L. castanea* and *L. africana* are more or less of the same length and colour, but *L. africana* may be recognized by the toothed tibiae of the twelfth pair of legs (Fig. 2C). The first-mentioned centipede was found almost throughout the areas visited, but *L. africana* occurred mostly in the north-western parts. A large red species, *Lamyctes denticulata* Attems, about 13,8 mm long, appeared in fairly fresh dung at Mamre and fed in captivity on soft-bodied insects.

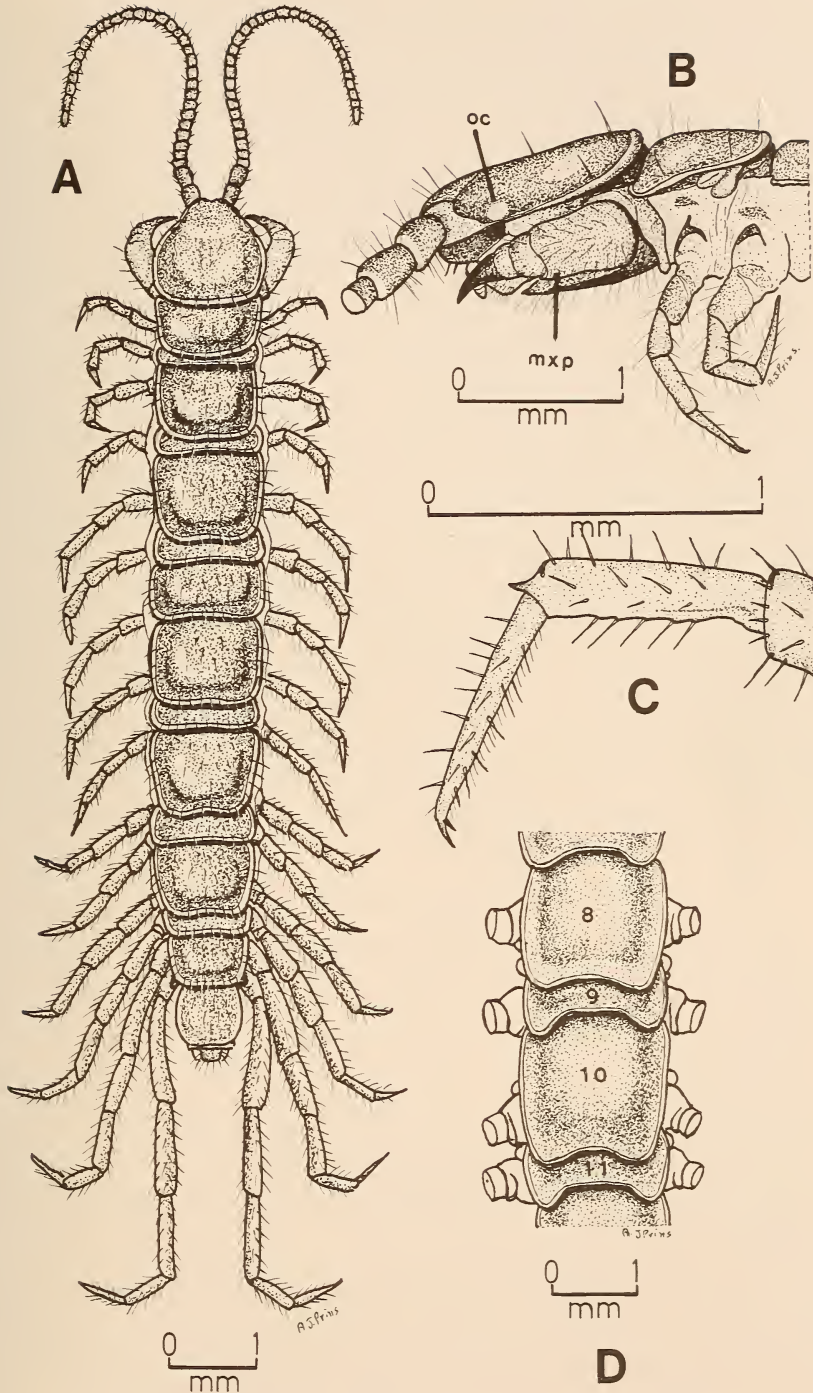


Fig. 2. A-B. *Lamyctes castanea*. A. Adult. B. Head of adult showing first and second pairs of legs, ocellus (oc) and maxillipeds (mxp). (Left lateral view.) C. *Lamyctes africanus*. Tibia and tarsus of twelfth pair of legs to show tibial tooth. D. *Lamyctes denticulatus*. Segments 8-11 to show denticulate posterior border of segments 9 and 11.

It differs from both *L. castanea* and *L. africana* by the toothed posterior angles of segments 9, 11, and 13 (Fig. 2D).

As these centipedes are long lived, both larvae and adults are usually found together. According to Cloudsley-Thompson (1957) the Lithobiomorpha (which includes *Lamyctes*) hatch with seven pairs of legs, including the poison claws, but this stage apparently lasts only for a few hours. Almost pure white, anamorphic larval forms of *L. castanea* with seven pairs of legs, excluding the maxillipeds (Fig. 3D) and measuring 1,3–1,5 mm in length, were observed in the soil around Cape Town during August. They are further characterized by the presence of an eighth pair of legs visible posteriorly through the integument. Eyes are apparently absent and the antennae consist of only six segments.

Anamorphic larvae with eight and ten pairs of legs (maxillipeds excluded) appeared in large numbers during August and September and in both cases two pairs of legs are visible posteriorly through the integument (Fig. 3A–C). The antennae are fourteen-segmented. The specimens with ten pairs of legs are somewhat larger, measuring 2,6–2,8 mm. In both forms the head and antennae are already pale yellowish red and the tergites, including the intercalary tergites, are fairly well defined; indications of eyes are present.

The final anamorphic stage larvae with twelve pairs of legs are very similar to those with ten pairs; however, in specimens collected during October, the antennae consist of sixteen segments and three pairs of posterior legs are visible through the integument. These larvae measure 2,6–3,5 mm in length.

Various groups of the second or final epimorphic stage individuals were observed during the late spring and almost throughout the summer and autumn. These specimens, with fifteen pairs of legs, measure 3,8–11 mm in length and their antennae consist of twenty segments in the 3,8 mm specimens, and thirty-one segments in the 11 mm specimens.

#### CLASS DIPLOPODA

Slow-moving herbivorous animals with cylindrical bodies characterized by presence of diplosegments, each bearing two pairs of legs. Ocelli present or absent. Defence is effected either by rolling up into a ball or by secretion of protective chemicals in segmentally arranged glands.

Millepedes are usually present wherever leaf litter or decaying dung is found, particularly the garden millepede, *Ommatoiulus moreleti* (Lucas), the large black *Harpagophora nigra* Attems, the black and reddish striped *Chersasus digrammus* (Pocock), a brownish species of the genus *Julomorpha*, the pale-brownish *Gnomeskelus repandus* Attems, and the hothouse millepede, *Orthomorpha gracilis* (Koch).

The last-mentioned millepede is widely distributed in the Republic of South Africa and, according to Causey (1943), its eggs hatch within 5–10 days (in the USA). He gives the size of the eggs as 0,35–0,41 mm. It is a polydesmid like *Gnomeskelus repandus*, and therefore has a fixed number of instars of which the eighth, with thirty to thirty-one pairs of legs, is the final or adult form (compare



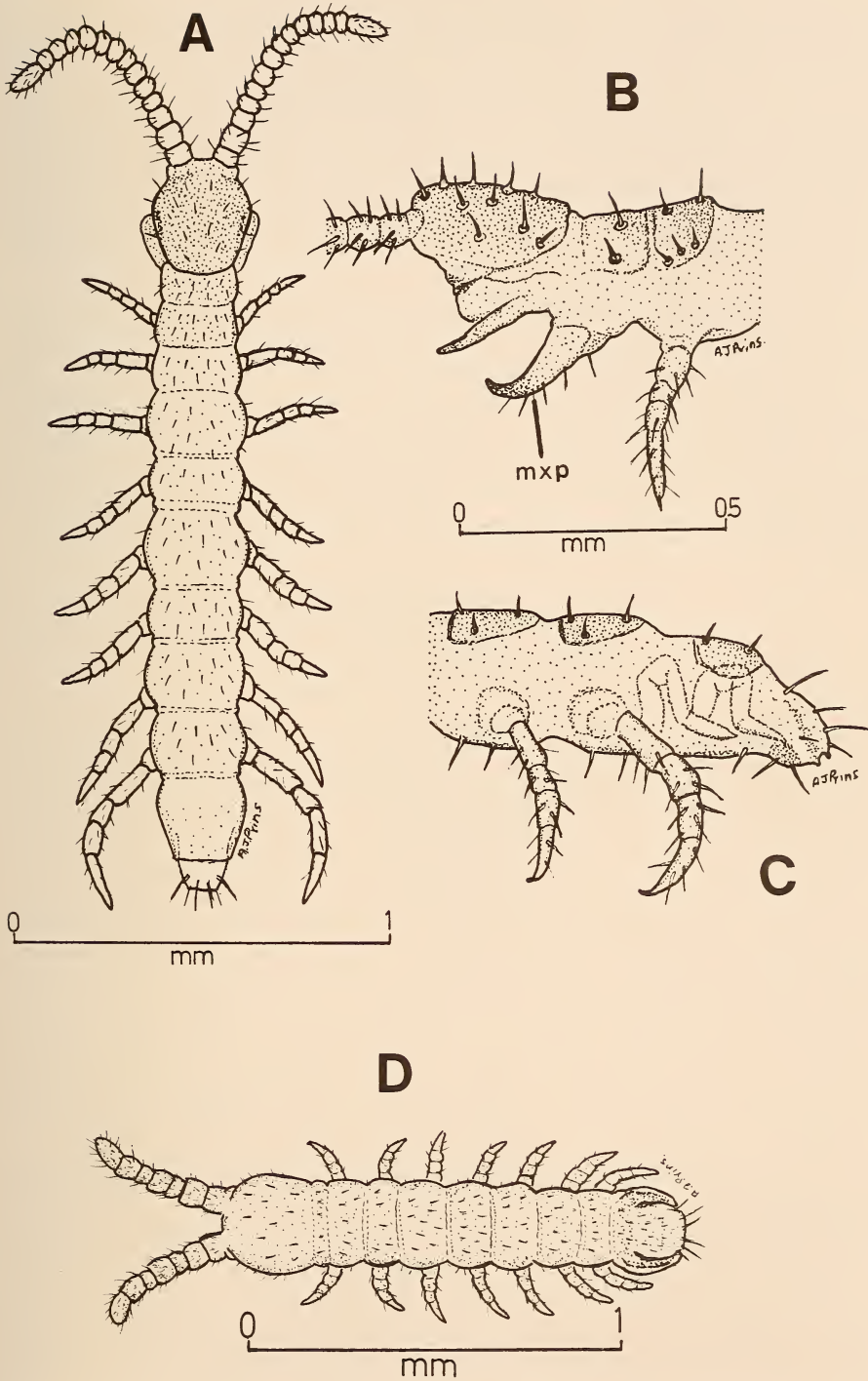


Fig. 3. *Lamyctes castanea*. A. Anamorphic larva with eight pairs of legs (dorsal view). B. Poison fangs (mxp) and first pair of walking legs of anamorphic larva (left lateral view). C. Last two pairs of legs of anamorphic larva (left lateral view). D. Anamorphic larva with seven pairs of legs (dorsal view).

with the juliformids, *Ommatoiulus moreleti* and *Chersastus digrammus* where a large number of instars occur).

A tiny unidentified dermestid-like pincushion millepede (Penicillata or Pselaphognatha) (Fig. 11H) was found together with *Ommatoiulus moreleti* under cow-pats near Jacob's Bay on the west coast. It is about 2,9 mm long, has twelve pairs of legs and is brownish red in colour with tufts of dark-brown, thick hairs on each segment including the head. It was seen to nibble on certain parts of the dung and its remains were often found in the shelters of reduviids of the genus *Coranus*.

Another unidentified species (the specimen collected is about 1,8 mm long with eight pairs of legs), which is pale yellowish white in colour, is often observed in leaf litter in the Cape Peninsula. It differs from the latter species by the longer hairs and antennae in relation to body size and by the almost glabrous dorsum, devoid of any hairs except for some long scale-like setae placed dorso-laterally. Its habits are unknown. The specimens of both the species collected are apparently immature, as adult forms usually have at least thirteen pairs of legs. Lawrence (1981) gives some idea of the life history of these millepedes.

#### ORDER JULIFORMIA

#### Family **Julidae**

#### *Ommatoiulus moreleti* (Lucas)

Adults small to medium sized, dark slate-grey to blackish in colour and 20–45 mm long when full grown. Characterized by longitudinal striae on each body segment and presence of a mid-dorsal posterior extension or tail. After the adult stage is reached, several further moults occur with an increase in the body length and the number of legs and ocelli, as is shown in Table 1 for adults collected around Cape Town and Philadelphia during January and February 1979.

This introduced millepede is almost cosmopolitan and is very widely distributed in the southern and western Cape. It was collected along the coast as far north as Citrusdal and as far east as Stilbaai. It sometimes occurs in very large numbers, particularly in soils rich in organic material, and may cause damage to young plants and even plant bulbs. It is often found in thatched roofs of houses together with scarabaeid larvae and it is quite possible that their way of feeding provides the correct stratum for these scarabs. Schubert (1966) gives a good description of the species and an almost complete distribution in the Cape.

It is commonly found in leaf litter as well as in soil rich in compost and other organic materials used as manure such as fishmeal, and is also attracted to decaying carcasses and human cadavers; on the beach it was often seen feeding on the dry remains of bird and seal carcasses and further inland even appeared at carcasses during the early part of the dermatophagous stage of decay. It was the only millepede found at wrack strings in the Cape Peninsula during the surveys. Together with *Chersastus digrammus* it usually appears in large numbers

TABLE 1  
Body length of adults of *Ommatoiulus moreleti* in relation to  
number of legs and ocelli.

<i>Number of leg pairs</i>	<i>Number of ocelli on each side</i>	<i>Body length in mm</i>
73	27	19.1
74	27	18.0
74	32	18.0
75	27	22.0
75	27	19.0
77	33	20.0
77	27	20.0
80	35	26.0
80	33	17.0
80	41	24.0
80	27	28.0
82	40	30.0
83	41	32.0
85	45	31.0
86	40	40.0
87	39	27.0
87	40	28.0
87	46	34.0
90	50	31.0

TABLE 2  
Body length of *Ommatoiulus moreleti* in relation to number  
of legs and ocelli.

<i>Number of leg pairs</i>	<i>Number of ocelli on each side</i>	<i>Body length in mm</i>
43	10	6.6
51	15	12.0
51	15	13.0
53	15	13.0
61	21	16.0
63	20	13.0
63	20	14.9
63	21	15.0
64	21	15.0
65	21	16.0
65	21	17.0
66	21	17.0
67	20	18.0
69	21	17.0

during April and May under semi-fresh cow-pats in sandy areas, feeding on the wet parts of the dung. It is also common under dry cow-pats.

Copulation between males (19,9 mm long with seventy-three pairs of legs), and females (32 mm long with eighty-three pairs of legs) of *O. moreleti* was observed near Philadelphia during May. In most cases this lasted for about 10 minutes and after a few days each female laid some 200 eggs in a small hollowed-out chamber in the topsoil. The eggs are somewhat oblong, slightly shiny and dirty, yellowish white, measuring from  $0,76 \times 0,64$  mm to  $0,80 \times 0,60$  mm. The incubation period in the laboratory was about 16 days at 22 °C. The first sign of the so-called preliminary hatching is a rupture in the chorion of the egg, after which the immobile, legless embryonic pupoid stage (Fig. 4A), which is still enclosed in an embryonic cuticle and is almost pure white, appears. About 4 days later the legs become visible through the membrane and anteriorly a tiny eye-spot appears on each side, and a pair of larger, darkish-orange spots also becomes visible at the posterior third of the body. This pupoid stage is about 1,0 mm long.

After about 6 days the embryonic cuticle is shed and the active first instar with three pairs of legs appears (Fig. 4B). It is about 1,6 mm long, still pure white and with about eight visible body segments. The darkish orange spot is then situated on about the fifth segment. After 5–6 days it moults again and then has seven pairs of legs (Fig. 4C) and one pair of eye-spots and the large lateral orange spot is then situated near the middle of the body. The first five trunk segments are more yellowish in colour and the body-length remains about 1,6 mm long.

In the case of *Chersastus digrammus* (Trigoniulidae) the second larval instar is slightly darker and three distinct black ocelli are visible on the head, but the dark posterior spot is much less conspicuous. Young specimens of the latter species were observed along the west coast during December, the smallest found being 5,3 mm long with a brownish, longitudinal median line on the dorsum, as in *O. moreleti*.

After 16–17 days the young larva moults again and is now about 2,8 mm long with seventeen pairs of legs and three clearly demarcated ocelli on each side of the head (Fig. 4D). This third instar is characterized by a pair of large, dark, reddish spots on the fifth body segment as well as five pairs of smaller, reddish, oval spots posterior to it (these are the openings of the repugnatorial glands). The posterior extension or tail and the antennae, which are very conspicuous at this stage, are already visible from the first instar. The body colour usually becomes darker and after about a month it moults for the third time, producing an individual with twenty-nine pairs of legs and six black ocelli on each side (Fig. 4E). It is then about 4,9 mm long and laterally bears eleven small reddish spots of which five are very conspicuous, in addition to the large spot.

This fourth stage lasts for about 25 days before it moults again and then reaches a length of about 6,2 mm. There are thirty-nine pairs of legs, ten ocelli and laterally eleven small, clearly defined, reddish spots and five inconspicuous spots in addition to the larger one on the fifth segment (Fig. 4F). The colour of

the body is pale brownish white, with a fairly broad, longitudinal, brown median line along the dorsum. This fifth instar lasts for about 32 days and again moults near the end of September. The sixth instar has about fifty-one pairs of legs and fifteen ocelli on each side of the head.

The number of legs varies apparently according to the sex of the animal and therefore fifth-instar specimens with forty-three pairs of legs and ten ocelli were often collected. As the animal increases in size, the number of legs and ocelli corresponds with the size of the millepede, as is shown in Table 2 (see also Table 1).

Baker (1978) described the post-embryonic development and life-history of this species in Australia and stated that after 1 year *O. moreleti* was in the seventh, eighth or ninth stage. After 2 years the tenth or eleventh stage was reached and after 3 years the twelfth or thirteenth.

#### CLASS ARACHNIDA

Arthropods with the prosoma (or cephalothorax) or both the prosoma and opisthosoma unsegmented; sometimes all the segments fused. Mostly terrestrial except for a few aquatic mites and spiders. No antennae, compound eyes or wings present. Respiration by means of tracheae, or book-lungs or both. Generally carnivorous and cryptozoic.

#### ORDER ACARINA

Mostly small arthropods, with the prosoma and opisthosoma completely fused. Larvae with three pairs of legs, nymphs exactly as adults with four pairs of legs but lacking the genital opening. In certain groups such as the Tetrapodili adults have only two pairs of legs.

Ticks (Ixodides) have the hypostome barbed and are usually parasitic on vertebrates. Only two species were found to shelter under semi-dry to almost dry cow-pats, namely the bont-legged tick, *Hyalomma truncatum* Koch and the red tick, *Rhipicephalus evertsi* Neumann. Both males and engorged females of the two species were recovered during March, *H. truncatum* in the Philadelphia district and near Saldanha and *R. evertsi* in the Stilbaai area. Males of *H. truncatum* measured 4,8 mm from the tip of rostrum to the posterior border of the body and were dark brown to blackish brown in colour. Engorged females were red and measured about 13 mm. Females of *R. evertsi* were somewhat under-developed, with light-red shields; their bodies were yellowish white and the legs pale reddish. The females of both species were embedded in the cake of the pats and, in the case of the red tick, large numbers of eggs were found with them. The eggs are roundly oval, dark reddish brown to wine coloured and shiny, and measure 0,52 mm in length and 0,38 mm in width. They hatched in about 50 days, producing transparent six-legged larvae measuring 0,60 mm shortly after hatching.

Mites (Acari), on the other hand, are usually small to minute with the hypostome smooth and without barbs, and are generally found in almost every

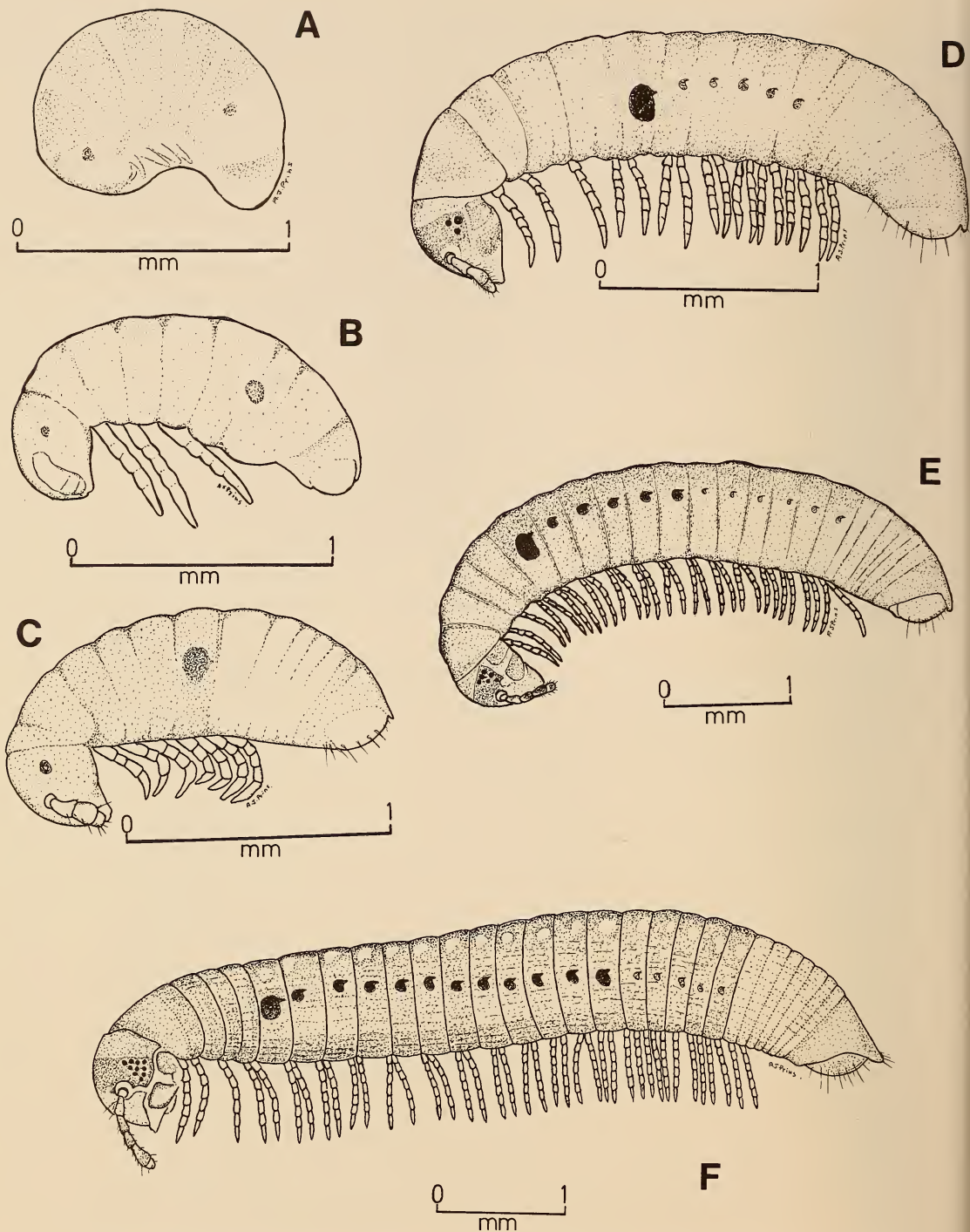


Fig. 4. *Ommatoiulus moreleti*. A. Pupoid stage. B. First stage. C. Second stage. D. Third stage. E. Fourth stage. F. Fifth stage.

habitat available to animal life. Some species are phytophagous, causing severe losses to crops, others again are parasitic and have developed a close relationship to man, such as the asthma epidermoptid, *Dermatophagoides pteronyssinus* (Trouessart), also known as the house-dust mite, which is associated with the scales of the human skin; it allergizes the bronchi by inhalation (Glass 1971) and contributes to allergic rhinitis and asthma.

Free-living mites are abundant in debris on the ground or in litter-like accumulations and particularly in soil rich in compost or other decaying organic matter. The most common species in the Cape Peninsula in soils containing decaying fish-meal was the Sarcoptiform, *Lardoglyphus zacheri* Oudemans (Fig. 5I), a minute whitish species only 0.2–0.24 mm long. This mite was also found to infest certain carcasses and when large numbers were present even the larvae of the skin beetle, *Dermestes maculatus* de Geer, were covered with numerous specimens. They apparently did not harm the insects at first, although their movements were slowed down. Later, however, after prolonged exposure to large numbers of this mite, growth was retarded and mortality increased.

In the oribatid mites (Fig. 5F) the bodies are usually strongly sclerotized and darkly coloured and some have large lateral shields or pteromorphs. They are fairly numerous in rich soils and may play an important role in digesting the organic matter (see also results by Fujikawa (1979) in Japan). They are found to be common around carcasses and one species of *Baloghobates* of the family Ceratozetidae, which has small pteromorphs, was found to accumulate in large numbers on the decaying leaves of *Arctotheca populifolia* along the Strandfontein sand-dune system during the summer and early autumn, in some areas actually feeding on the growing plants.

The variable Trombidiformes include a large number of phytophagous species as well as several parasitic mites, particularly of the family Tarsonemidae of which one species of *Tarsonemus* (Fig. 5D) was very common on a large variety of arthropods. It is small, about 0.24 mm long, whitish, and with long setae on the hind legs. In the Karoo it occurred in exceptionally large numbers on the larvae of the skin beetle, *Dermestes maculatus* de Geer, feeding on the droppings of the Cape grey mongoose, *Myonax pulverulentus* (Wagner). Heavy infestations of this species on insects in breeding jars in the laboratory usually resulted in the death of the hosts. This mite, together with one species of pyemotid (Fig. 5E), was found to be common around Cape Town in the soil surrounding half-buried carcasses. The latter is also very small, about 0.5 mm in length, almost globular, and pure white in colour. Specimens observed during the dermatophagous stage of decay of various carcasses were found to feed on the eggs of skin-and-hide beetles. The grain itch-mite, *Pyemotes ventricosus* (Newport), another member of the family Pyemotidae and normally beneficial as it is parasitic on the larvae of grain-infesting insects, may cause skin irritations or eruptions in humans handling infested material. (This mite is not to be confused with the human itch-mite, *Sarcoptes scabiei* (de Geer) (Sarcoptiformes) which is transmitted by direct contact with infested persons or domestic animals.)

Prostigmatid mites of the genus *Pimeliaphilus*, also belonging to the sub-order Trombidiformes, have been found in association with various reptiles and arthropods in different parts of the world. Olivier (1977) described four species from South West Africa of which three were found on insects, viz. *P. penrithi* Olivier on cockroaches of the genus *Derocalymma*, *P. buysi* Olivier on the tenebrionid beetle, *Stips dohrni* (Haag) and *P. desertus* Olivier on the carabid *Anthia thoracica* (Fabricius) (see also discussion on Scorpionida). Most of these species also seem to be free-living under stones and debris.

In completely dry cow-pats only two undescribed species of prostigmatic caeculid or rake-legged mites were found. The one species, observed along the west coast, is about 2,5 mm long, its body trapeziform and broad. Its colour is brownish to greyish marked with black; the front and sides of the shield are whitish and the legs are black marked with white. Body-hairs are sparse and spatulate. The front legs are strongly developed, with long golden-brown spines on the inner surface.

The other xerophilous species collected in the Karoo is much smaller, about 1,6 mm long, piceous brown, and covered with longer hairs. It lacks the white marks of the former species. The colour of these mites blends with that of the dry dung to bring about a perfect camouflage. In the laboratory they were seen to stalk other mites, but otherwise their habits are unknown. Lawrence (1939) maintains that they are probably scavengers, feeding on decaying animal remains.

A large variety of mostly unidentified mesostigmatid mites were very common in both fresh and semi-fresh cow-dung. These included various *Macrocheles* species such as *M. distanti* Evans & Hyatt (Fig. 5A), *M. peniculatus* Berlese, and *Parasitus* species (Fig. 5B). An unidentified crimson, prostigmatid spouted mite of the genus *Bdella* (Fig. 5G), about 1,6 mm long, appeared regularly but was not abundant in semi-fresh pats. One of the most numerous species in decaying dung was a small, whitish mite about 0,32 mm long and very similar to *Parasitus* sp.; it is probably also a member of the Parasitidae. These species are all predacious, the snouted mite feeding on the Collembola present.

Specimens of *M. distanti* that were collected measured only 1,1–1,2 mm long, with the holodorsal shield yellowish brown in colour; specimens of *M. peniculatus*, on the other hand, were somewhat bigger, 1,2–1,4 mm long, and darker in colour. *Macrocheles distanti* is commonly found on various scarab beetles such as *Onitis*, *Scarabaeus* and *Circellium* species (Evans & Hyatt 1963). *Parasitus* species are more or less oblong mites and, although of the same colour as the above-mentioned species, they are easily distinguished by the divided dorsal plate; their legs are also more slender and more or less of the same size, whereas in the macrochelids the first pair is elongate and much thinner than the others. All these mesostigmatid species also occurred in decaying animal carcasses and human cadavers.

Some of the *Macrocheles* species are ectoparasites of flies, as they are often found attached to their hosts, their mouth-parts deeply embedded in the tissues



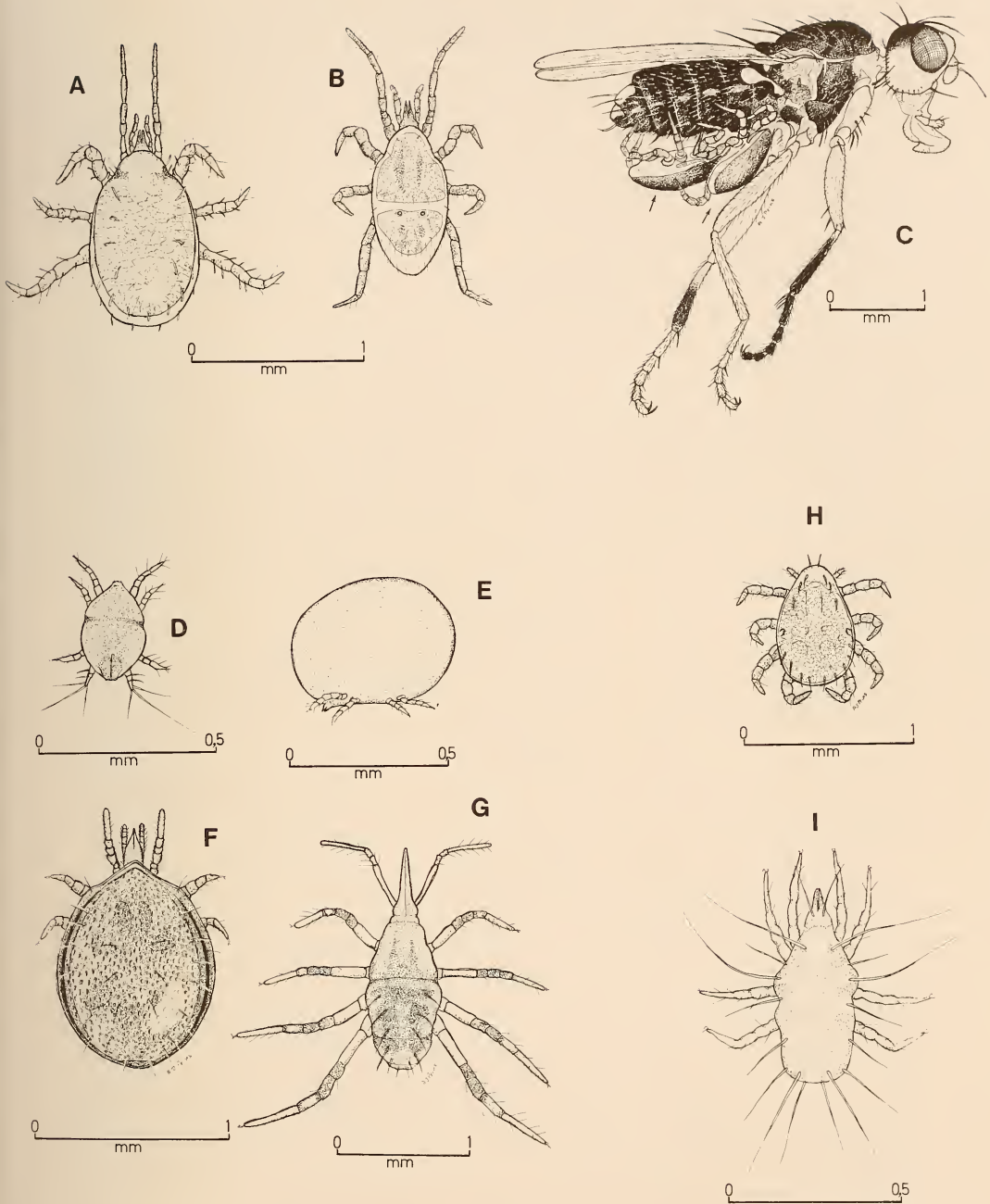


Fig. 5. A. *Macrocheles distanti*. B. *Parasitus* sp. C. Cheese skipper, *Piophilina megastigmata* McAlpine, with two mites, *M. distanti* attached to abdomen. D. *Tarsonemus* sp. E. Pyemotid mite. F. Oribatei mite. G. *Bdella* sp. H. *Aleuroglyphus* sp. I. *Lardoglyphus zacheri*.

between the segments (Fig. 5C). Phoresy, therefore, seems to be one of the main factors influencing the presence and abundance of these mites in cow-pats and carcasses. According to Axtell (1963) several species of the family Macrochelidae are predacious on house-fly eggs and first instar larvae.

The mesostigmatic poultry mite, *Dermanyssus gallinae* (de Geer), is often found to shelter in roosting sites of birds in human dwellings, particularly in air-vents, and may cause minor infestations. In some respects it resembles the larger *Parasitus* species, but may be distinguished by the absence of a clearly divided dorsal plate.

Decaying kelp yielded numerous mites, mainly Mesostigmata and Sarcoptiformes, especially of the families Laelaptidae and Acaridae. Various species of a brownish *Peletiphis* have been seen, while the acarids were represented by a pale-brown, parasitic *Aleuroglyphus* sp. (Fig. 5H). Often kelp-flies were so heavily infested with them, particularly on their legs, that their movements became sluggish. Most of the mites are about 0,68 mm long. A *Parasitus* sp. (Fig. 5B) also occurred and was found to feed on the eggs of flies laid on the kelp. It was noticed that when disturbed each mite snatched an egg and disappeared with it among the kelp leaves. When fly maggots or beetle grubs were preyed upon by predacious beetles and their larvae, these mites were seen to approach the prey and imbibe some of the available body fluids.

#### ORDER ARANEIDA

In the spiders the abdomen is usually unsegmented except in the Liphistiomorphae; in this suborder as well as in the Mygalomorphae, which includes the baboon-spiders, the fangs move up and down. In the rest of the spiders the fangs move from side to side (or in and out).

Most spiders are poisonous and, although necrotic ulceration or loxoscelism is caused by the cytotoxic venom of the violin spiders, most of them, such as the baboon-spiders and the button-spiders, have a neurotoxic poison.

At least four species have been observed in debris in the sand, on dunes, and on the supratidal zone of the beach. These are mostly burrowing spiders and they disappear very quickly under the sand when left on the surface. The most common of these were the armoured spiders (family Zodariidae) (Fig. 6C), and a small theraphosid. Occasionally a species of *Clubiona* (family Clubionidae), found on the dunes, occurred under semi-dry crow-dung both along the south and west coasts, while one species of the family Ctenidae also frequently appeared under the stranded kelp and debris in the western parts.

These are all small spiders of which the feeding habits are unknown. However, there is evidence to believe that some of the zodariids prey on the small fly larvae in the sand, particularly those of the horse-flies belonging to the genus *Limata*, which occur in this stratum.

Spiders were common in both semi-fresh and semi-dry cow-pats; the most widespread appearing to be the wolf-spiders (family Lycosidae). A small *Pardosa* sp., easily recognized by the broad, brown longitudinal band on each side

of the pale carapace, the arrow-like pale line down the middle of the abdomen, and the mottled legs, occurred throughout the region surveyed, most often together with a larger unidentified species. The latter, about 15 mm long, has a similarly marked carapace, but its pale-brown abdomen is mottled with dark brown.

Wolf-spiders were also found to be the most common arachnids under stranded kelp, and a small species of *Lycosa* (pale reddish-brown with a broad, brown longitudinal stripe along each side of the body, the middle of the abdomen whitish) was very numerous, particularly along the west coast; it was sometimes in association with members of the family Ctenidae, which in some respects resemble the wolf-spiders. A larger species, about 10,5 mm long and rather similar to the *Lycosa*, its abdomen marked with dark brown, seemed to be just as common along the south coast. Most of them feed on the smaller insects, particularly the flies that are attracted.

The large, brown hairy baboon-spiders, *Harpactira* spp. and the lesser baboon-spiders, *Harpactirella* spp. (family Theraphosidae), particularly *H. lightfooti* Purcell, have all been collected under semi-dry to almost dry cow-pats along the west coast as far north as Port Nolloth. In some cases the nests were hollowed out in the pats, while in others they were just below the surface of the soil, their tunnels leading into the pats. *Harpactirella* spp. are very similar to those belonging to *Harpactira*, but differ from them by the absence of a brush of short stiff hairs on the external side of each chelicera. The bite of *H. lightfooti* is of medical importance (Newlands 1972). Specimens of *Harpactira* when in a state of moulting are very susceptible to the attacks by pentatomids of the genus *Halyomorpha*. An unidentified dark-grey species, very near *H. viridescens* Walker and about 13 mm long, was found in the vicinity of Saldanha feeding gregariously on fairly large specimens of the brown baboon-spider.

Small (1,9 mm long) blattid-like nymphs, found in the same area, probably belong to this shield-bug. They are pale greyish yellow on the thorax and connexivum, with greyish-yellow legs and antennae and crimson abdomen.

The family Drassidae were also well represented. In the Saldanha and Veld-drif areas *Amusia cataracta* Tucker (Fig. 7B), *Zelotes* sp., and an unidentified species very near *A. cataracta* were mostly present. They are all small, sombre-coloured, brownish to pale bluish-brown spiders. A similar but much paler species of *Anagraphis* was common almost throughout the region, and in the vicinity of the Gouritz River mouth an unidentified *Drassodes* sp. appeared in pats containing large numbers of dipterous and scarab larvae. Its colour is pale brownish red, the abdomen lighter with brownish spots on the posterior half, and it is easily separated from the other drassids by its long chelicerae carried almost horizontally.

The erigonids resemble in some ways small theridiids (button-spiders), but the males and females are about equal in size. However, in the males there is a raised area or knob on the front part of the carapace on which their eyes are situated. Most of them are very small and sombre coloured and five to six

species were well represented under semi-dry pats, the most common being a species of *Araeoncus*. Other small spiders observed in dry dung were species of *Heriaeus*, *Clubiona* and the lungless spiders, *Caponia*, which resemble baboon-spiders.

One of the most beautiful spiders that shelters under semi-dry cow-pats is the tiny spitting spider, *Scytodes* sp. (Fig. 6A) (family Sicariidae), which is yellowish white with dark-brown stripes and spots on the body. It is easily recognized by its strongly convex and bulbous carapace. Specimens collected near Saldanha measured only 3–4 mm in length. Prey consisted mostly of small flies, silver-fish, and other small insects, which are usually immobilized by a sticky saliva.

Nests of the brown or house button-spider, *Latrodectus geometricus* Koch (family Theridiidae), were not uncommon under pats and it was observed to feed on various beetles and other soft-bodied insects such as cockroaches. The black widow, *L. mactans* Linnaeus, on the other hand, was much scarcer and only two nests were observed in the vicinity of Leipoldtville during April, both under large dry pats, each nest with one or two smooth, oval, white egg cocoons containing the exuviae of newly hatched spiders. The prey included tenebrionid beetles, the most abundant victims being the elongate, brownish *Oxura setosa* Kirby (16,5–19 mm long) that shelters under dry cow-pats during the summer and is characterized by the two acute posterior prolongations of the elytra. Hesse (1942) gives an almost complete list of insect victims of this spider, including this tenebrionid. Skeletons of an almost equal number of a black *Onymacris* sp. (about 14 mm long), and a few shiny brown *Ograbies subdentatus* Koch (7,5–8,3 mm long), were among the remains of the one nest, together with almost intact specimens of a small black *Psammodes* sp. and a *Zophosis* sp., both varying in length from 9,9 to 13,0 mm.

It is interesting to note that the sphecid *Chalybion spinolae* (Lepelletier) provisions its nest with both species of button-spiders. According to observations, this wasp accounts for the destruction of a large number of the black widow in certain areas (J. E. Nel, Durbanville, 1983 pers. comm.).

At least eight spiders were found in the Cape Peninsula in soil surrounding carcasses, of which a dark crimson species of *Dysdera* (family Dysderidae) was the largest (approximately 14 mm). It has a pale-reddish abdomen and exceptionally long chelicerae and was particularly abundant during the summer and autumn. Young individuals collected during the summer varied from 3 to 5 mm long and were almost pure white. The comb-footed spiders (family Theridiidae) included a small brownish *Enoplognatha* sp., its abdomen marked with white stripes and patches, and an even smaller *Anelosimus* sp. (Fig. 7A), which is pale brown with darker brown on its abdomen.

An unidentified *Erigone* sp. (Fig. 6B) (family Erigonidae), probably the same species that was found under cow-pats near Hermanus and Darling, has the spinners surrounded with black. It occurred together with a related button-spider-like linyphiid and some larger dictynids (mesh-web spiders) under fairly decayed carcasses. *Hahnia* sp. (family Agelenidae), about 4 mm long, with

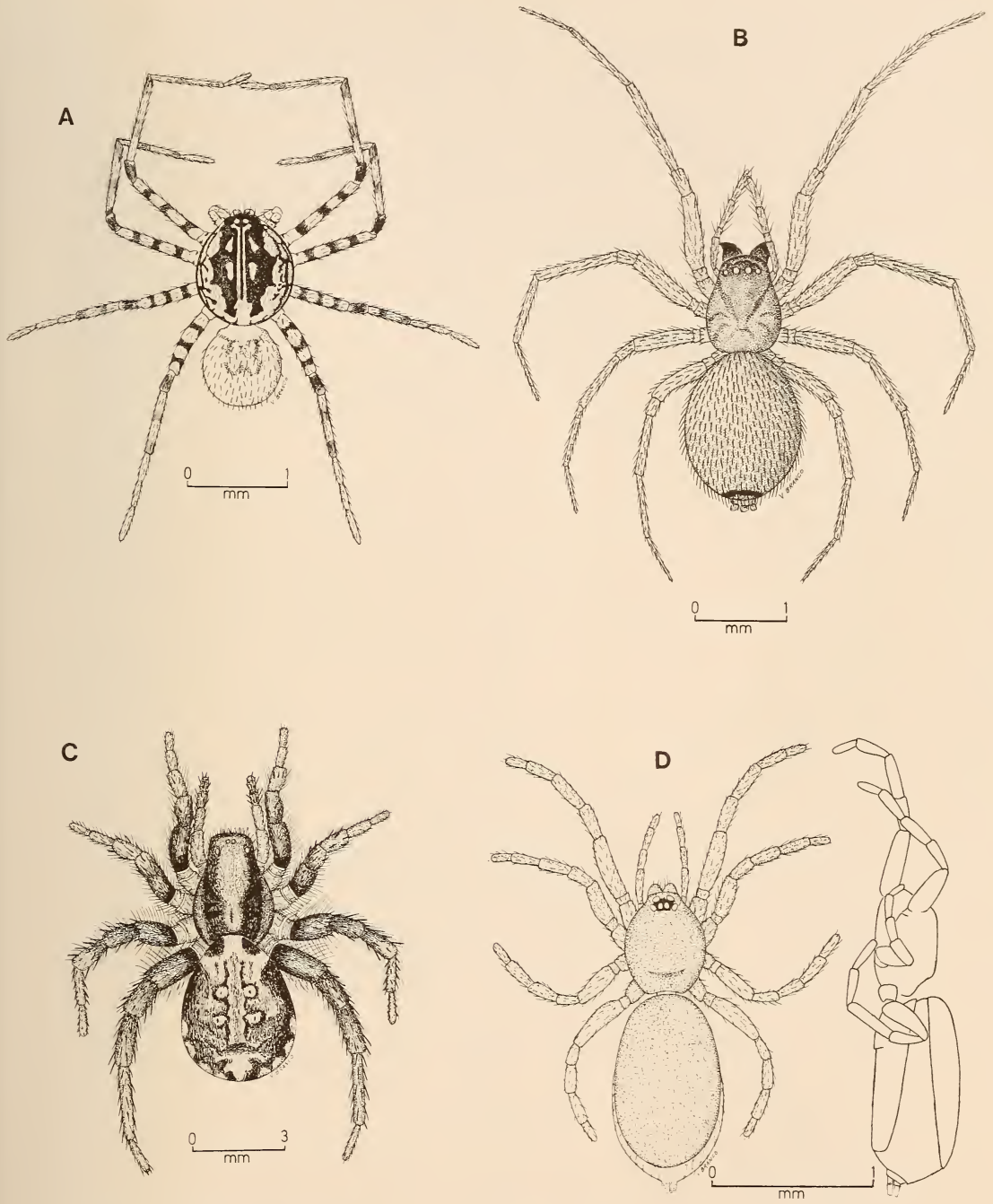


Fig. 6. A. *Scytodes* sp. B. *Erigone* sp. C. Zodariid spider. D. *Gamasomorpha australis* (dorsal and left lateral view).

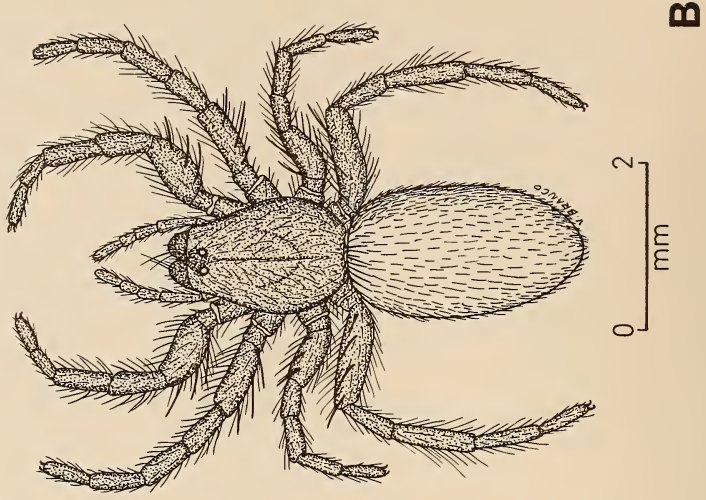
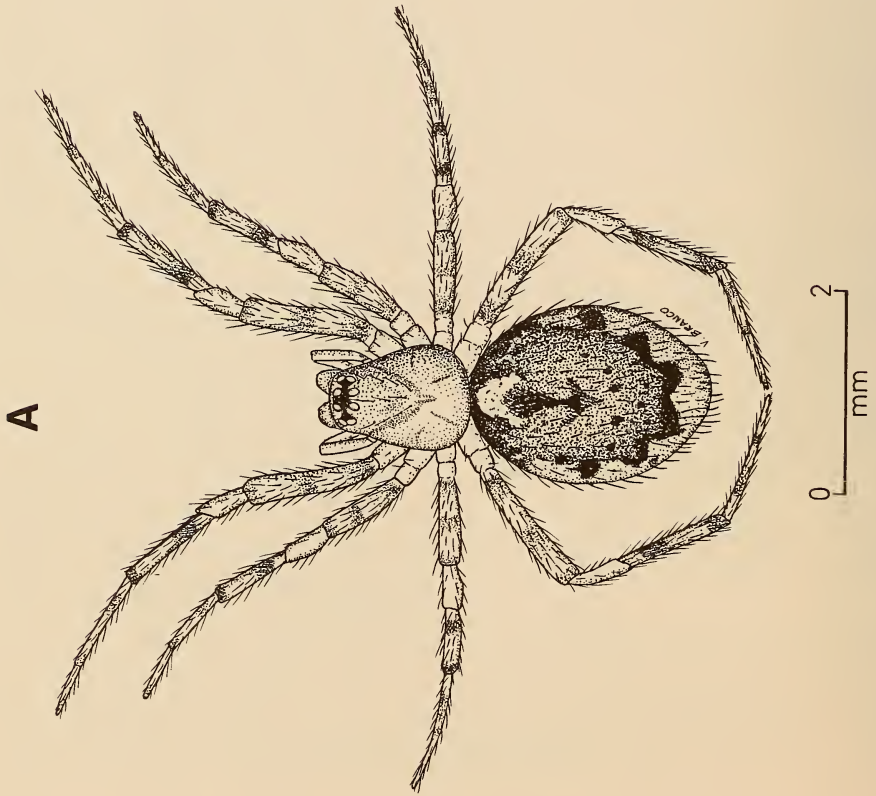


Fig. 7. A. *Anelosimus* sp. B. *Amusia cataracta*.

brownish, speckled abdomen, appeared in places where the soil was fairly damp. Its long spinners are placed in a line along the posterior border of its abdomen; young individuals collected were almost white.

One of the smallest spiders collected in the soil partly covering carcasses was the bright brownish-red *Gamasomorpha australis* Hewitt (family Oonopidae) (Fig. 6D), which is only 1.8 mm long and easily recognized by the two oval shields covering the abdomen.

Apart from the true spiders, only one brownish harvest spider of the genus *Opiliones* (order Phalangida), which is generally found under stones along the west coast, was collected under dry cow-pats. It feeds on other spiders, flies, and snails. Near Saldanha Bay a young specimen (37 mm long) of an unidentified *Solpuga* sp. (order Solpugida) appeared during midsummer under a large dry pat and, judging by the remains found near it, this animal must have been feeding on the scorpions *Uroplectes variegatus* (Koch) and a *Parabuthus* species.

#### ORDER SCORPIONIDA

Fairly large nocturnal carnivores with segmented opisthosoma divided into pre-abdomen or mesosoma, bearing ventrally openings of book lungs and paired comb-like pectines, and with the tail or metasoma with apical sting. Usually one pair of dorsal eyes present on cephalothorax and groups of two to five lateral eyes.

These animals, which include burrowing, arboreal, and rupicolous members, are usually characteristic of arid environments; however, habitat selection as in the other arthropods is governed by ecological factors such as vegetation, geology, and climate.

Their venom apparently consists of two types in which the one produces only local reaction without systemic effects except in cases of hypersensitivity. This is usually found in species with a thin metasoma and large flat hands on the pedipalpi such as the yellow Cape scorpion, *Opisthophthalmus capensis* Herbst (family Scorpionidae), a species that was periodically observed under large cow-pats.

In the family Buthidae, however, the venom is a neurotoxin, comparable to that of the colubrine snakes, and may be lethal. In this family the scorpions have a thick metasoma and the hands of the pedipalpi are ovoid, slender, and rather small. Only one large species, *Parabuthus capensis* Hemprich & Ehrenberg, rarely occurred under dry cow-pats during the surveys and was found to prey on the smaller and more common *Uroplectes variegatus*. The latter and *Parabuthus brevimanus* (Thorell), the smallest species in the genus, are fairly common under dry cow-pats all along the west coast where surveys were made.

#### Family **Buthidae**

##### *Uroplectes variegatus* (Koch)

Full-grown females (32–45 mm long) (Fig. 8G) vary from pale cadmium yellow to yellowish brown; some are mottled with brown, with three rather indistinct longitudinal stripes over middle of dorsum; most of them, however,

have only a single broken, median line and body segments are marked with light brown. In all the specimens examined, the largest part of the fifth metasomal segment is darker in colour than the rest; in some specimens it is piceous brown, in others very slightly darker. It is rather similar to *Parabuthus brevimanus* both in shape and size, but differs from it by the longitudinal body stripes, *P. brevimanus* being of a more uniform coloration.

This species was found inland along the west coast throughout the year, usually only one specimen per dry cow-pat. Sometimes six out of every ten pats examined harboured at least one specimen during the summer months; these scorpions varied from very young (about 12 mm total length) to full-grown females. In the case of the full-grown specimens, the under surface of the cow-pats was hollowed out in the form of a chamber in which the animals sheltered.

In the Karoo near Laingsburg, where collections were made during the autumn, *U. variegatus* was replaced by pale yellowish-brown immature specimens of *U. schlechteri* Purcell, which also has a dark fifth metasomal segment; the tail segments, however, are more slender and longer than in *U. variegatus*.

Adults of *U. variegatus* living in association with the pugnacious ant, *Anoplolepis custodiens* (Smith), in the Citrusdal district were found by Eastwood (1978) to be parasitized by the trombidiform mite *Pimeliaphilus isometri* Cunliffe, which is also found on scorpions in the Philippine Islands (Baker & Wharton 1952). Eastwood regarded this South African scorpion as *U. carinatus* but, according to Lamoral (1979), this species occurs only in the northern regions of the Cape; *U. variegatus*, on the other hand, is confined to the north-western and south-western Cape. It is interesting to note that a similar mite *Pimeliaphilus cunliffei* Jack, in the U.S.A., uses the cockroach *Periplaneta americana* (Linnaeus) as its natural host (Cunliffe 1952; Jack 1961).

Pregnant females of this species and of *Parabuthus brevimanus* were observed during September to December, and newborn young were actually found during the middle of December to the middle of February. Pregnant dissected specimens of *U. variegatus* yielded fourteen to twenty embryos of which most were situated on the sides of the mesosoma. The fully-developed bean-shaped embryo (Fig. 8C) is enveloped in a transparent membrane and has the metasoma folded in under the body. According to observations made, the gestation period is fairly long, probably lasting a year. Newly emerged young are pure white with black eyes (Fig. 8B) and an inconspicuous, longitudinal median line on the dorsum of the mesosoma; the body is devoid of setae except for a few setae on the pedipalpi (particularly on the fingers) and two or three setae on the last two apical segments of the legs.

After birth the young immediately climb on to the mother's back and after a few days the penultimate metasomal segment becomes pale purplish. Two days after birth they measure 7,2 mm from the tip of mouth-parts to the tip of the sting. The developing mouth-parts, claws and sting are still enveloped in the membranous covering during this stage and are freed only at the first moult, which occurs 10 days after birth. At this stage the larvae are almost 10 mm long



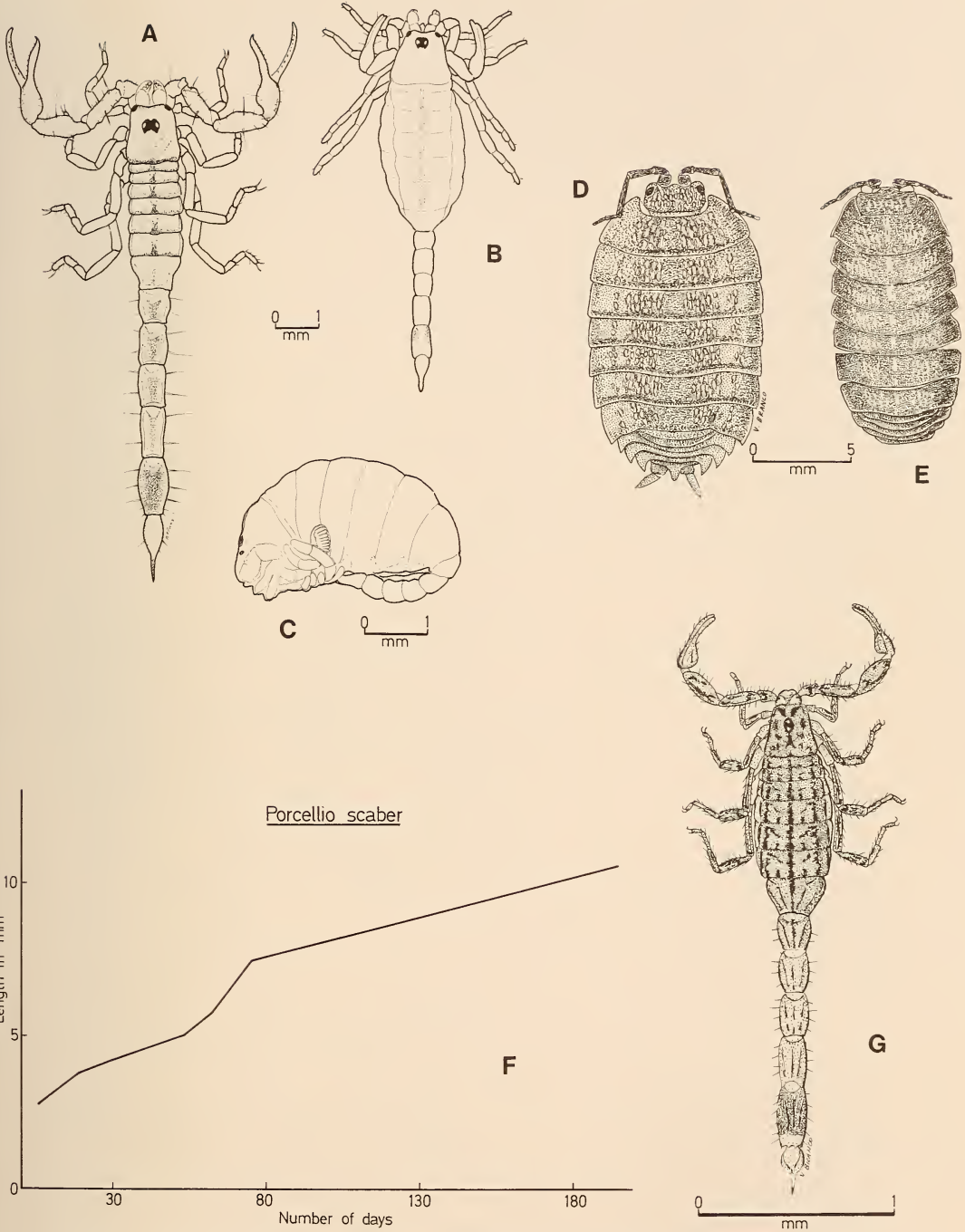


Fig. 8. A-C, G. *Uroplectes variegatus*. A. Eleven days after birth. B. Two days after birth. C. Fully developed embryo in adult female. G. Young female. D, F. *Porcellio scaber*. D. Adult. F. Increase in body length of the larvae of *P. scaber* as observed in the laboratory. E. *Armadillidium vulgare* (adult).

(Fig. 8A) and, although still very pale, the penultimate metasomal segment is clearly darker than the rest and the longitudinal median line on the mesosoma is much more conspicuous. The apical metasomal segment is pure white and the apical half of the sting brown. The legs are almost white and at this stage some of the young already begin to leave the mother, although they still cluster together on the ground. Body hairs are much more abundant, particularly on the pedipalpi and metasoma; they now clearly resemble the adult, except for the much narrower mesosoma.

#### CLASS CRUSTACEA

Mostly aquatic arthropods with calcareous exoskeletons in contrast to the chitinous covering of insects; with two pairs of antennae and usually five pairs of legs.

The majority are free-living. They may be vegetarians, predators, or scavengers.

Destruction of stranded kelp by arthropods is mainly brought about by the large numbers of halophilous crustaceans, both Isopoda and Amphipoda. Their presence on the beach is indicated by numerous tunnels in the stems of decaying plants; the crustaceans and large kelp-flies undoubtedly form the most important part of the wrack fauna that was examined.

#### ORDER AMPHIPODA

Body usually compressed, thoracic limbs without exopodites and with first pair modified as maxillipeds.

Apart from *Orchestia gammarella* Pallas, very few species seem to be eucoenic and some of the *Talorchestia* species observed were even found to breed in semi-fresh cow-dung in the laboratory. At least four species of the more common amphipods were collected during the surveys, namely the Atlantic species *T. capensis* Dana (Fig. 9I), the above-mentioned widespread *O. gammarella* (Fig. 9F), which is also found in North America, and the endemic *T. quadrispinosa* Barnard, which is known to prey on other beach-hoppers, including *T. capensis* (Branch & Branch 1981) and *T. australis* Barnard (Fig. 9G). All the species of these light grey to whitish beach-hoppers or sand-fleas are very similar and mostly scavenge between and just above the intertidal zone, although some have been found rather far above the supratidal zone on the small dunes. From the available data it seems as if *T. australis* and *O. gammarella* are more restricted to the southern parts of the Cape, while *T. capensis* and *T. quadrispinosa* are more widely distributed along the west coast.

The indigenous *Talitrus eastwoodae* (Methuen) (Fig. 9H), which is very similar to the beach-fleas but has reddish transverse bands over its body, is a scavenger confined to forests (Lawrence 1952). It was found in rather large numbers around Cape Town in the vicinity of Table Mountain at carcasses lying in shady surroundings. In the Cape Peninsula it is often found under carpets in houses during the warmer parts of the year.

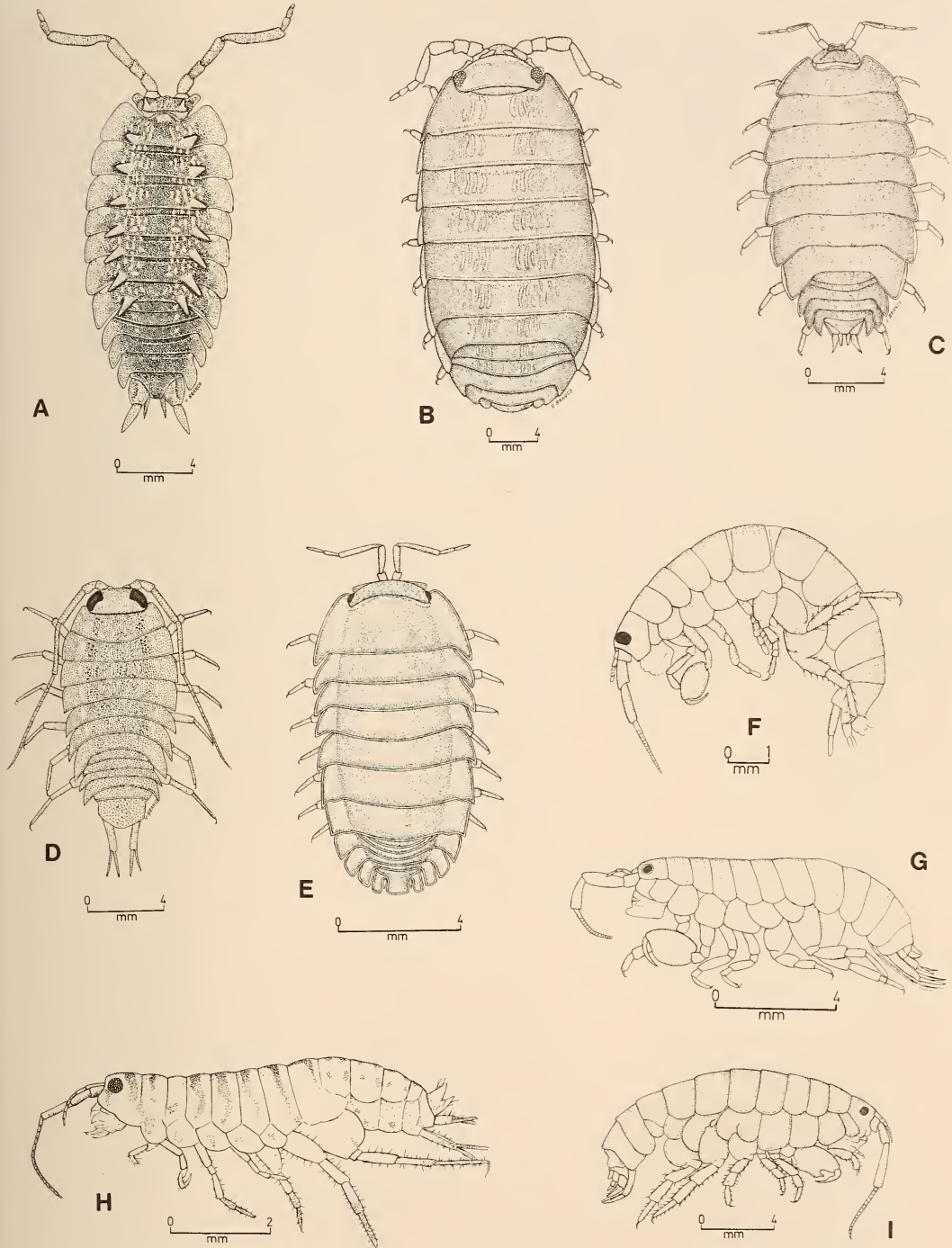


Fig. 9. A. *Deto echinata*. B. *Tylos capensis*. C. *Marioniscus spatulifrons*. D. *Ligia dilatata*. E. *Bethalus* sp. F. *Orchestia gammarella*. G. *Talorchestia australis*. H. *Talitrus eastwoodae*. I. *Talorchestia capensis*.

## ORDER ISOPODA

A large, variable group with depressed bodies. Thoracic limbs also without exopodites and first pair always modified as maxillipeds.

The majority are aquatic, but the oniscoid group has adapted to terrestrial or semi-terrestrial life.

The largest species present under kelp is *Tylos* (length up to 50 mm), of which there are two species, *T. capensis* Krauss (Fig. 9B), occurring from the Cape Peninsula eastwards along the coast, and *T. granulatus* Krauss with a westerly distribution. The biggest difference between the two seems to be the texture of the integument, which is granulate in the case of *T. granulatus* and minutely granulose in *T. capensis* (Barnard 1932); their distribution and morphological similarity, however, seem to indicate that one may rank as a subspecies. According to Kensley (1974), both species are omnivorous but with a bias towards a herbivorous diet.

Most of the isopods are rather slow-moving, except *Ligia* species, which are also characterized by the long antennae and uropods. The common greenish-brown to olive-grey sea cockroach or shoreslater, *L. dilatata* Brandt (Fig. 9D), is widely distributed along the south and west coasts. When collections were made in wrack during the winter months, large numbers of this isopod were found to carry small, round, yellowish eggs (0,92–0,76 mm diameter) in their marsupia.

*Deto echinata* Guerin (Fig. 9A), slate to greyish green with lighter specks, is also widely distributed from the Namaqualand coast to Cape Agulhas. Large numbers (some with eggs) were usually present under the kelp during the winter, and very often they were found in seal carcasses in the intertidal zone. They were often found to prey on other arthropods. The slightly smaller *Marioniscus spatulifrons* Barnard (Fig. 9C), of similar coloration, has more or less the same distribution as *Deto echinata*, and was usually in association with the latter. *Bethalus* species (Fig. 9E) are darker orange in colour and were mostly found during the winter under semi-dry wrack strings along the south coast.

## Family Oniscidae

*Porcellio scaber* (Latreille)

Full-grown females (Fig. 8D) are 15–16 mm long, with a brownish-grey colour, mottled with pale or creamy white; colour variation, however, is considerable. It cannot roll up into a ball and its uropods are much longer than those of *Armadillidium vulgare* (Latreille) (family Armadillidiidae, see below). Males somewhat more slender with longer uropods.

This species is widely distributed in South Africa and is found in many places in the world (Barnard 1932).

Adult sow-bugs collected during the first week in September from soil containing decaying carcasses moulted about 10 days later, and after a month produced about 50 larvae. The latter were kept under observation in the laboratory and were found to produce larvae 194–200 days after birth. The increase in size

of the larvae with age is shown graphically in Figure 8F. The average monthly temperature during the day during the period of observation varied from 21° to 29 °C in September to March and from 18° to 24 °C in April and May.

Young larvae of about 2 mm in length are nearly white with blackish eye-spots. As their size increases, the colour becomes darker and after about 20 days they are already pale brownish grey and inconspicuously mottled with dirty white. After about 80 days they look exactly like their parents and are fairly dark brownish grey, mottled with creamy white. According to Heeley (1941), who gives a good account of their biology in England, the development of the young may be regarded as complete by about the fifth moult.

This eurytopic sow-bug is omnivorous and was found to feed on various materials, including decaying kelp. It is very common under loose bark (Heeley 1941, Cloudsley-Thompson 1957). It is often found in large numbers under fresh and semi-fresh cow-pats and plays a vital part in the destruction of the remaining parts of the dung, especially when the number of fly maggots begins to decrease. It is sometimes attracted to rotting carcasses and may remain throughout the decaying process.

#### Family Armadillidiidae

##### *Armadillidium vulgare* (Latreille)

Adult females (Fig. 8E) about 14,6 mm long and dark slate grey in colour, mottled with paler spots similar to those of *Porcellio scaber*, but forming a definite, inconspicuous, pale longitudinal band over the middle of the dorsum.

This species is very widely distributed in South Africa as well as other parts of the world (Barnard 1932).

Its biology is very similar to that of *P. scaber*, but *A. vulgare* seems to produce more young than the latter. However, in specimens observed during the surveys the survival rate of the very young larvae was much lower than in the case of *P. scaber*. Young larvae about 1,7 mm long, collected during January near a turtle carcass, were (as in the latter species) almost pure white with black eyes. After about a month the body already showed four brownish, longitudinal lines and the colour gradually darkened until maturity was reached. The growth of specimens kept under conditions similar to those of *P. scaber* was, however, much slower and 200 days after birth some larvae were still only 5 mm long.

This pill bug is mainly omnivorous and is common around houses; it was abundantly collected in leaf litter and compost heaps all over the Cape Peninsula. Both Heeley (1941) and Paris (1963) give valuable information on the life cycle of this species, which is considered by Brereton (1957) to prefer the shade of stones both in open land and in woodlands. It often occurs in very large numbers together with *P. scaber* under semi-fresh to fresh cow-pats, and is also attracted to decaying carcasses. Albino forms, which are often present among individuals of this species, point to a calcium deficiency in the soil. They are highly dependent on humidity and are, therefore, always found in locations that are fairly damp.

## CLASS INSECTA

## ORDER BLATTODEA

Family **Blattidae**

Dorsoventrally compressed exopterygote hexapods with cursorial legs, well-developed cerci and multi-segmented antennae. Wings usually well developed, but some are apterous. A few species are sub-social, some are gregarious, and they may be oviparous, ovoviviparous, or viviparous; an ootheca of a tough leathery substance is produced during oviposition.

Although they are usually omnivorous, there is evidence that the Table Mountain cockroach, *Aptera fusca* (Thunberg), is a plant-feeding species as it was observed to feed on the berries of a *Cuscuta* sp. (Skaife 1979). In the Cape Peninsula it was sometimes observed under stranded kelp on the intertidal zone, but repeated efforts to feed the cockroach on this medium were in vain. It often congregates in familial groups under stones and dry cow-pats as is the case with other veld species such as *Deropeltis erythrocephala* (Fabricius) (Fig. 10J).

Of the oviparous species, the American cockroach *Periplaneta americana* (Linnaeus) drops the ootheca long before the eggs hatch. This is also the case with the indigenous *Pseudoderopeltis foveolata* (Walker), whereas the female of the German cockroach *Blatella germanica* (Linnaeus), on the other hand, carries the ootheca externally until shortly before the eggs hatch. This was also observed in some specimens of the short-winged mountain cockroach, *Temnopteryx phalerata* (Saussure), although evidence seems to indicate that this species behave rather like *Periplaneta americana*. The Madeira cockroach *Leucophaea maderae* (Fabricius), which occurs in many parts of the world and is widespread in the Subsaharan region (Cornwell 1968), including Natal and probably also Transvaal, is ovoviviparous. Like *D. erythrocephala*, it is gregarious and may form large colonies outdoors and, according to Scharrer (1951), in Brazil twenty-five to thirty-two young are produced at one time during the warm weather. It has been found in sugar-cane on certain North Atlantic islands.

For many years it has been suspected that cockroaches carry pathogens such as *Mycobacterium tuberculosis* (Schroeter) (observed in the faeces of *Blatella germanica*), *Salmonella typhimurium* (Loeffler) (gastro-enteritis), and *Chlostridium perfringens* (Veillon & Zuber) (gaseous gangrene and one of the causative organisms of normal decay in carcasses and cadavers), as well as various other organisms including viruses (Roth & Willis 1957, 1960). Even the organism that causes bubonic plague, *Yersinia pestis* (Lehmann & Neumann), has been found in specimens of the oriental cockroach or black-beetle, *Blatta orientalis* Linnaeus, collected in infected areas (Roth & Willis 1957). The natural vectors of plague are fleas (Siphonaptera). Cockroaches are also capable of causing allergic dermatitis (Smith 1973).

Parasitoids include wasps of the genus *Tetrastichus*, reared from the oothecae and sphechids of the genera *Ampulex* and *Dolichurus*, which provision their

young with cockroaches (Arnold 1928; Roth & Willis 1960). Mites have already been mentioned (see discussion on Arachnida).

*Pseudoderopeltis foveolata* (Walker)

Princis (1963) has described the adults (Fig. 10A). Females black and fairly shiny, with vestigial mesothoracic wings. Depressed sixth and seventh tergites are characteristic of this genus. Cerci ten- to twelve-segmented in all females collected and fairly broad and compressed dorsoventrally; penultimate segment in most cases the longest. Antennae multisegmented (at least sixty to seventy segments).

This species is widely distributed in South Africa, Zimbabwe and Lesotho (Princis 1963). It was collected in the interior under semi-dry cow-pats together with other *Pseudoderopeltis* spp. (Fig. 11E) and *Perisphaeria* spp. (Fig. 11F-G), whereas cow-pats on the beach or on the sand-dune biotope produced mainly the psammophylic cockroaches *Blepharodera discoidalis* (Brunner) (Fig. 11D) and *B. ciliata* Burmeister (Fig. 10F). *B. discoidalis* is a blackish species whose body is surrounded by a pale yellowish white margin; *B. ciliata* is mottled with brown; the adult females of the latter measure up to 30 mm in length and males up to 25 mm with a wing-span of 65 mm; nymphs are mottled with grey and resemble the apterous females, except for size. Both species are usually found under the sand near the stems of plants and both adults and nymphs have been collected on the beach under the stems of *Tetragonia decumbens* and *Arctotheca populifolia* during October to December. The *Perisphaeria* spp. vary from pale light brown, mottled with darker brown, to almost black.

Oothecae of *P. foveolata* (Fig. 10D), produced from December to January by adults collected along the west coast, are 7,9–8,8 mm long and are all about 4,9 mm broad. Initially the ootheca is reddish white, but soon darkens to a pale brownish red and eventually to a red-brown, with the keel somewhat paler. The dorsal serrations are rounded, not acute. In this species the ootheca is held upright while the eggs are being deposited, with the keel fitting in the V-shaped groove in the tenth tergum (Fig. 10B). The ootheca is dropped as soon as all the eggs have been laid and buried about 5 mm deep in the soil. The incubation period varies from 47 to 56 days.

The newly hatched young (Fig. 10C) are pale piceous to yellowish brown in colour, 3,3–3,7 mm long, and smooth and shiny. In all the specimens examined the cerci are three-segmented as in *Periplaneta americana* (Guthrie & Tindall 1968) and the antennae twenty-two-segmented. The sixth and seventh tergites are already depressed in the first instar. The young nymphs remain clustered together on the ootheca for at least 4–5 days, during which time they turn almost black.

The first moult was observed 17 days after hatching and by this time they were about 5,5 mm long. After moulting they are pale whitish brown with almost black eyes. In all the second instar nymphs the cerci are six-segmented,

with the penultimate segment the longest. The antennae are twenty-five- to twenty-six-segmented. In the laboratory development was slow and after about a month the nymphs were only about 6 mm long, the antennae consisted of twenty-seven to thirty segments and the cerci were still six-segmented. After about 120 days their length had increased to 10 mm, the cerci were now seven- to eight-segmented and the antennae thirty-five-segmented. Nymphal growth over a period of about 130 days is shown graphically in Figure 10E. Some specimens reached maturity only 3–6 months later.

*Temnopteryx phalerata* (Saussure)

Princis (1963) has given a detailed description of this species. General body colour of adult (Fig. 10G) light yellowish brown, abdominal segments darker brown, posterior borders of pronotum and abdominal segments pale yellow. Legs and antennae yellowish brown, latter multisegmented (more than seventy segments). Cerci twelve-segmented, measuring about 3,7 mm in adult females. Total length of body 18–25 mm. A peculiarity of this species is the uneven number of tarsal segments on the hind legs; out of twenty-five specimens examined, with only one exception, the hind tarsi on the right side had four segments while those on the left had five.

According to available collecting data it is endemic to the Cape where it is widespread along the west and south coasts. This cockroach, which is often observed in leaf litter both on the coastal sand-dune area and in the interior, has on several occasions been found to feed on certain types of carpets in the Cape Peninsula; damage reported so far, however, was apparently only very slight.

Whereas in *Pseudoderopeltis foveolata* the ootheca is always held upright during oviposition, in this species it is held flat (Fig. 10G) as in the case of the German cockroach, with the keel in all the specimens examined pointing to the right side. The oothecae (Fig. 10I) are 10,8–15,4 mm long and 3,5–3,7 mm wide and most of them are dark brown to dark reddish brown in colour, including the keel of which the serrations are clearly dentate and close together. Oothecae of this species are very similar to those of *Deropeltis erythrocephala* (Fig. 10K), common under cow-pats, but in *Deropeltis* spp. the serrations resemble those of *Pseudoderopeltis foveolata* and are lighter in colour. In *Temnopteryx phalerata* the ootheca in most specimens examined was retained by the female for a day before being buried under 1–2 mm of sand. The incubation period varied from 32 to 39 days during February at a temperature of 30–31 °C. In a few specimens the ootheca was carried for a longer period before being dropped.

Newly hatched nymphs measure 3–3,2 mm in length and are pale yellowish brown with two white oval spots on the metanotum; the eyes are reddish. The nymphs soon turn almost black (Fig. 10H) but the posterior borders of the thoracic segments and the first three abdominal segments, as well as the two metanotal spots, remain white. A thin white line also runs over the head and thorax. The legs are piceous with the apical third of the middle and hind femora, as well



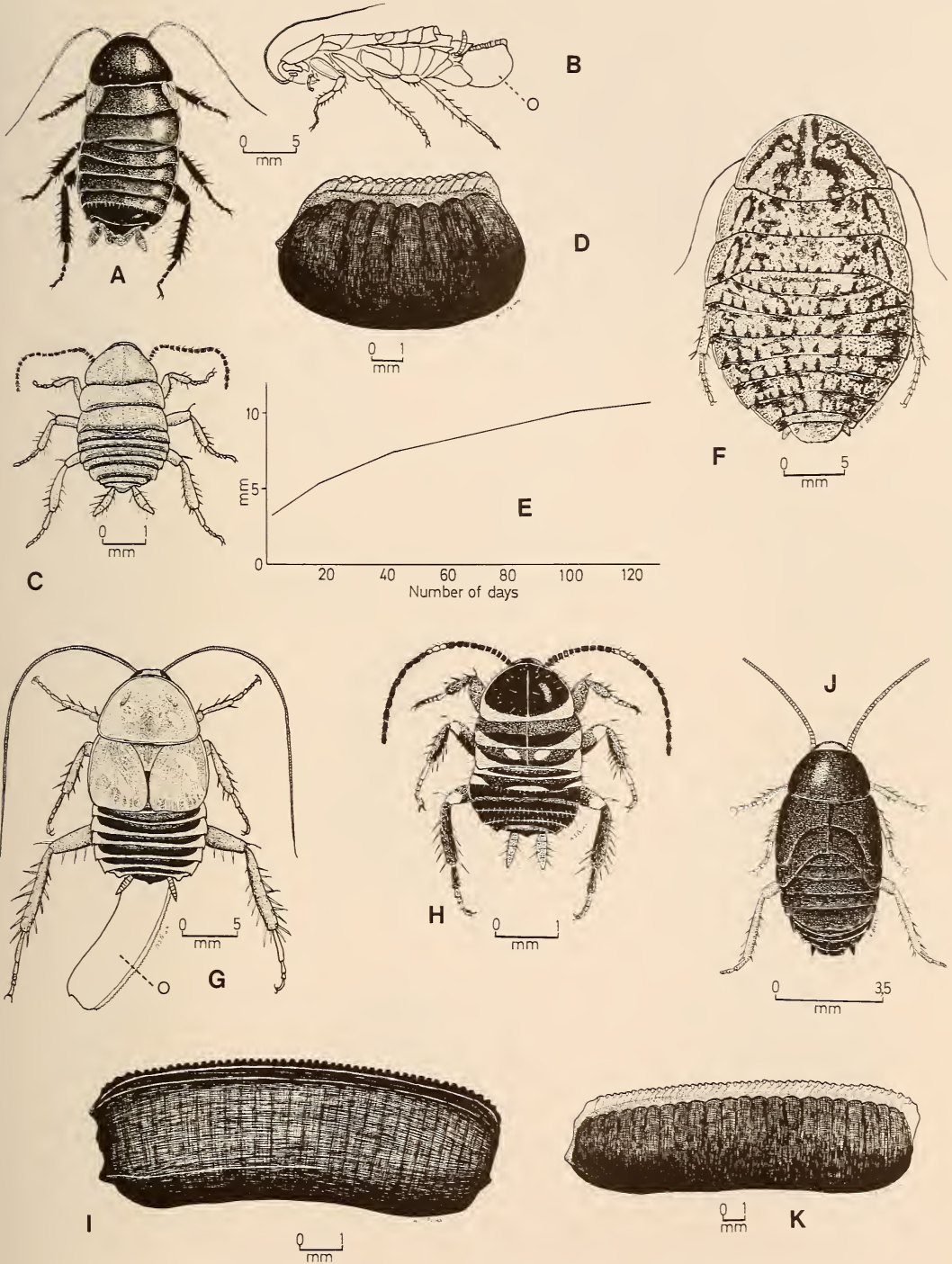


Fig. 10. A-E. *Pseudoderopeltis foveolata*. A. Female (adult). B. Female (left lateral view) to show oviposition and ootheca (o). C. Newly emerged larva. D. Ootheca. E. Body increase of larvae as observed in the laboratory. F. *Blepharodera ciliata* (adult). G-I. *Temnopteryx phalerata*. G. Female with ootheca (o). H. Larva at about 30 days. I. Ootheca. J-K. *Deropeltis erythrocephala*. J. Female (adult). K. Ootheca.

as the tarsi and the apical half of all the coxae, white. The antennae are twenty-two-segmented, with the second to fourth, the thirteenth and about one-third of the twelfth and fourteenth segments white in some specimens. In many specimens the thirteenth to the fifteenth segments, as well as the second to fourth, are also white, the remainder black. The cerci are piceous and three-segmented as in the other species. In the first instar the tarsi are five-segmented in all the legs.

Development was very slow and after about 161 days the nymphs were only about 5 mm long and coloured as shown in Figure 10H. The antennae had thirty-three to thirty-four segments, with the twenty-first and twenty-second segments white; the cerci were six-segmented.

Unfortunately, due to an invasion of mites and the excessive use of the insecticide Carbaryl to combat ants, most of the specimens died before maturity was reached.

#### ORDER MANTODEA

#### Family **Mantidae**

Elongate predacious exopterygote hexapods, usually with well-developed cerci, large eyes and raptorial forelegs. Antennae multi-segmented and pronotum long; wings usually well developed, absent in some females. Solitary insects producing oothecae of a tough material. Subsociability is known to occur in some species.

#### *Oxypilus nasutus* (Fabricius)

Full-grown females (Fig. 11B) 17–20 mm long, apterous and mottled with dark brown or dark grey and yellowish white. Very striking light coloration on ventral side of the abdomen and on front femora. As in most mantids, front femora spined on ventral side, with five spines on exterior margin, of which basal ones are largest. The three discoidal spines (Fig. 11B) large and agree with those described by Loxton & Nicholls (1979) for *Hierodula membranacea* (Burmeister), suggesting that this is a generalized predator. Front coxae also have six to seven spines on anterior margin. Males similar to females, but more slender, with a wing-span of 45–50 mm.

This species is widely distributed in South Africa and South West Africa, and is fairly common along the west coast, particularly in Namaqualand. It appeared occasionally in the vicinity of Saldanha Bay under plants growing on the edge of the fore-dune system adjoining the beach. It is very well camouflaged against the debris and remains of plant seeds that are found under plants such as *Arctotheca populifolia* and is therefore very rarely seen. Prey included small mantids, blow-flies and other soft-bodied insects.

Oothecae (Fig. 11C) collected during December varied from 8 to 16 mm in length and were glued to the seeds and to leaf litter under the plants. They are whitish when freshly produced, but after about a day become reddish brown to

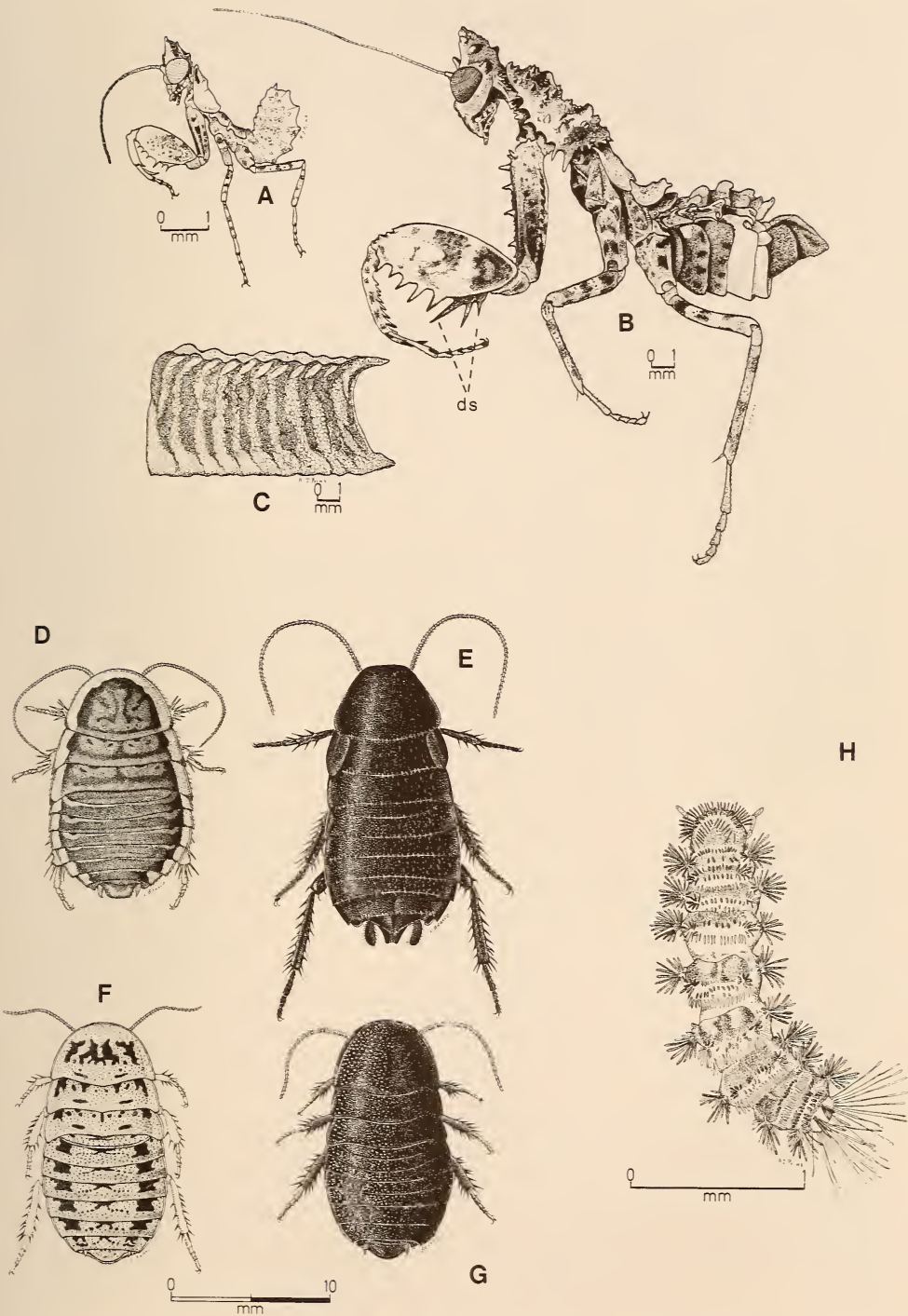


Fig. 11. A-C. *Oxyphilus nasutus*. A. Newly hatched young. B. Adult showing discoidal spines (ds). C. Egg packet (lateral view). D. *Blepharodera discoidalis*. E. *Pseudoderopeltis* sp. F. *Perisphaeria* sp. G. *Perisphaeria* sp. H. *Penicillata*, sp. indet.

dark brown with the dorsal edge yellowish white. The incubation period of the eggs was about 45 days.

The newly hatched mantids (Fig. 11A) are approximately 4,2 mm long, mottled with brown and pale yellowish white, except the last four or five abdominal segments, which are pale, almost white in colour. The eyes are large and pale brown. Almost the whole of the pronotum and the tibiae as well as the apical third of the front femora are white. As in the case of the adults, there are five spines on the exteroventral margin of the front femora, but the anterior margins of the front coxae are devoid of any spines. Exteroventral margin of front tibiae has only one strong spine.

In larger nymphs (8,5 mm long) taken during January and which exhibit the coloration of the adult, the anterior margins of the front coxae possess six to seven spines and the exteroventral margin of the front tibiae at least two developed spines and smaller dentations indicating the position of five more spines present in the adult form.

#### ORDER DERMAPTERA

Elongate exopterygote hexapods, cerci modified into forceps. Legs cursorial, antennae fairly long with variable number of segments. Forewings reduced to tegmina, hind wings membraneous, sometimes lacking. Mostly omnivorous; however, species of the family Hemimeridae are parasitic, such as *Hemimerus talpoides* Walker, living in the soft fur of the large African pouched rat, *Cricetomys gambianus* Waterhouse, and feeding on parts of the skin, fungus spores and other debris (Rehn & Rehn 1935, Walker 1964). Subsociality and viviparity are known to occur in some earwigs.

Only a few species were collected during the surveys, mainly under cowpats, of which *Labidura riparia* (Pallas) and an unidentified species were the most abundant. The latter, a brown earwig with pale yellowish stripes and markings giving it a mottled appearance, was found to be very common in dry pats near Saldanha Bay. Only wingless specimens, 11–16 mm in length (forceps included), with dark-brown heads and usually with two small, oval, lighter yellow marks on the front, were collected throughout the year. They were found to shelter in the crust and cake of the pat, their colour blending well with the surroundings, making them difficult to find. Their legs are pale, marked with brownish patches and the antennae dark brown with the apical borders of segments 15 to 16 white.

Young larvae of this earwig measuring 5,2–7,8 mm in length had the same colour as the adults, but were pale, sometimes pale yellowish and with the posterior part of the body darker as in the adults. The number of antennal segments varied in the immature stages from eleven (5 mm specimens) to fourteen (7 mm specimens) and the yellowish patches seemed to be absent on the head. These nymphs and their exuviae were observed in the pats during both summer and winter.

One light-brown specimen of the genus *Esphalmenus* was collected under an almost dry cow-pat in open sandveld, near the sand-dune system in the vicinity of Elands Bay during April. It is about 15 mm long (including the forceps) and differs from *E. peringueyi* (Bormans), *E. capensis* Brindle and *E. ecarinatus* Brindle, the only three other species of this genus described from South Africa, by having a strong tooth on the last tergite, just in front of the base of each branch of the forceps; the latter also carries a large tooth. Nymphs of the pyrrhocorid *Scantius forsteri* (Linnaeus), sheltered under the same pat.

### Family Carcinophoridae

#### *Euborellia annulipes* (Lucas)

This earwig is always apterous (Fig. 12A). Females collected are dark reddish brown to piceous brown, but the pronotum (and in some specimens also the meso- and metanotum) is usually paler in colour. Antennae have sixteen to eighteen segments in most females examined, with fourteenth or thirteenth to fifteenth white. Forceps more or less straight. Males similar to females, except that forceps are more curved, particularly on right side (Fig. 12C). Antennae consist of fourteen to sixteen segments, with twelfth or twelfth to fourteenth white. Hincks (1947) and Brindle (1978) give good descriptions of males and females.

This species is cosmopolitan and widely distributed in Africa and is the most widely distributed earwig (Brindle 1978). It is very common in the Cape Peninsula and is often attracted to decaying carcasses, feeding on the organic material and on insects and other arthropods present under such conditions. It is a nocturnal species, attracted to houses by lights and, according to observations, it is thigmotactic as in the case of *Labidura riparia*. It was never encountered on the beach or on the dune system during the surveys.

Although this species appeared during the last post-mortem stage of decay when the surveys were made, it may, depending on various factors such as weather conditions, location of the carcass and the species of arthropods present, be attracted at a very early stage, as is the case with ants, certain beetles, arachnids, and chilopods.

Males and females were found to copulate during October. When mating the male and female face away from each other and the male's abdomen is twisted so that the genitalia on the ventral side are brought into contact with those of the female. Copulation in most cases lasted for about 2 minutes and most females produced a batch of 44–50 eggs about 18 days afterwards. Eggs were also found during the late summer and early autumn.

The eggs (Fig. 12B) are spherical, shiny white and almost without any sculpturing. They vary in size from  $0,88 \times 0,76$  mm to  $1,06 \times 0,90$  mm and are laid in a ground cell excavated by the female, who remains in the cell with the eggs. When disturbed the female carries the eggs away to a new excavation, or else devours them. The incubation period is at least 16 days.

The newly hatched nymph is pure white with brown eyes and about 3,4 mm long including the forceps, which measure 0,68 mm in the specimens examined. The antennae at this stage consist of eight segments. In about 3 days' time they turn to a pale yellowish brown, the head and posterior three or four abdominal segments becoming somewhat darker. The legs remain whitish, with a darker transverse band at about the middle of the femora. The penultimate antennal segment is also white (Fig. 12D).

At the age of 19 days the number of antennal segments have increased to eleven (after which stage the first moult apparently occurs) with the penultimate or, in some cases, the ninth segment remaining white. The general body colour is yellowish brown, with the head somewhat darker and the legs paler. About 44 days after hatching another moult takes place and the antennae consist of thirteen to fourteen segments, with the eleventh segment white. The body length is then 6,5–7,0 mm. The nymphs were observed to moult again after about 64 days from the time of hatching and the antennae were then found to consist of fifteen to seventeen segments in most cases. In the laboratory the developing nymphs required about five moults to reach maturity, but some specimens moulted only four times. The size increase over a period of about 150 days is shown graphically in Figure 12E. According to Hincks (1947) there are five instars and the third instar has thirteen-segmented and the fourth instar fourteen-segmented antennae.

#### Family Forficulidae

##### *Forficula peringueyi* (Burr)

Females (Fig. 12F) measure about 10 mm, forceps included; reddish brown in colour, with the posterior five segments almost black. Males fairly similar to females and measure 11–11,6 mm, forceps excluded; latter long, in most cases measuring about 7,5 mm (Fig. 12G). In both sexes antennae are eleven-segmented. Characteristic of both males and females are the lateral tubercles on third and fourth abdominal tergites, those on fourth being the largest. Brindle (1973) gives a description of the sexes.

This species is endemic to the Cape and, according to Brindle (1973), restricted to the western parts where it is common under debris and stones; it has been found to nest in cow-pats during the winter. The immature stages of this species look very much like those of *F. promontorii* (Burr), which was mainly observed along the south coast, but they seem to be more shiny.

Eggs (Fig. 12K) were found in hollowed-out chambers in fairly dry cow-pats during July. They are oval and measure  $1,2 \times 0,72$  mm; most of them are shiny, creamy white to whitish yellow and without any form of sculpture. As in the case of *Euborellia annulipes*, the females usually tend the eggs.

Newly emerged nymphs (Fig. 12L) measure about 3,7 mm including the forceps, and are pure white but soon turn to a pale brown, the head and posterior two to three segments being somewhat darker. The antennae are eight-segmented and of the same colour as the body; the forceps are fairly long and

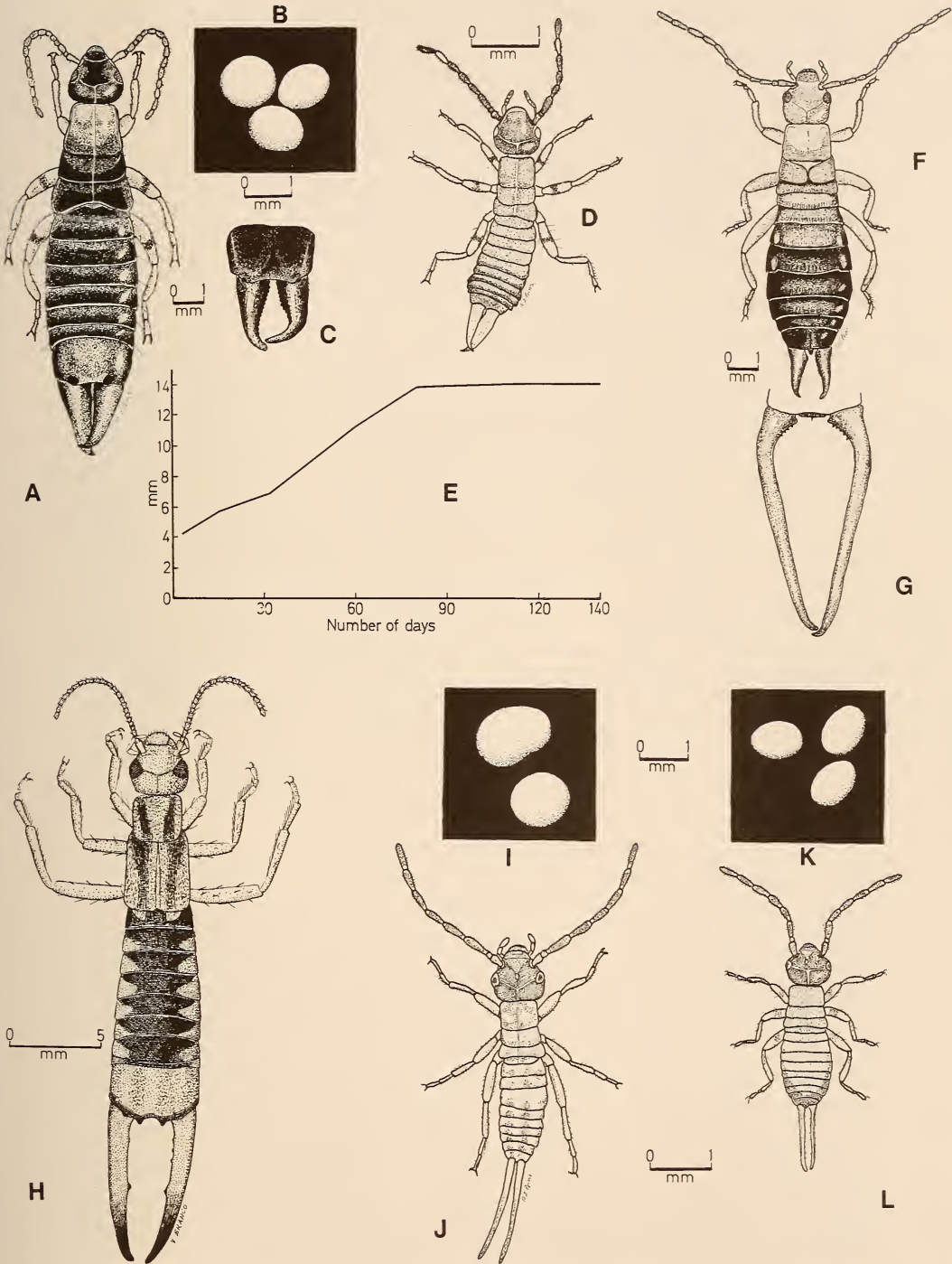


Fig. 12. A-E. *Euborellia annulipes*. A. Adult. B. Eggs. C. Forceps of male. D. Nymph at 3 days. E. Increase in body length of nymphs as observed in the laboratory. F-G, K-L. *Forficula peringueyi*. F. Adult female. G. Forceps of male. K. Eggs. L. Newly hatched nymph. H-J. *Labidura riparia*. H. Adult. I. Eggs. J. Newly hatched nymph.

measure 1,1 mm. Observations show that the nymphs require 4–5 months to reach maturity.

### Family **Labiduridae**

#### *Labidura riparia* (Pallas)

This is a large species (Fig. 12H), specimens examined measuring 20–26 mm in length, including the forceps. Usually dark reddish brown, with central area of abdomen darker, in the shape of two longitudinal, median bands; pro- and mesonotum also with two darker stripes. Antennae and legs yellowish. Antennae consist of more than twenty segments, with fourth to about seventh shorter than the others. Brindle (1973) described both sexes.

This earwig is cosmopolitan and common in Africa, particularly along the shore (Brindle 1973). It is mainly a predator and generally feeds on the smaller staphylinids and scarabs and their larvae as well as on other beetles such as *Gonocephalum* spp. It is attracted to light and is therefore often seen in houses during the night. It is sometimes also attracted to semi-fresh cow-dung on the beach. According to Callan (1964) the pale sand-coloured ecotype is a maritime form restricted to sandy habitats of the coast. During this survey, however, only the dark ecotype was found both on the beach and inland. Moderately pale forms occurred only in the young nymphal stages.

In certain areas along the west coast it was seen to visit dried-out sea-birds on the high-water mark and was found to feed on other arthropods, particularly fly larvae, and on bits and pieces of the flesh still left on the skeletons. Near Elands Bay it was observed in large numbers together with the cicindelid *Platychila pallida* Fabricius in the top few millimetres of sand under the plant *Arctotheca populifolia* in the supratidal zone; they were associated with the larvae of the beetle *Melyris viridis* Fabricius, on which both predators fed. This earwig is very common under dry cow-pats in sandy areas.

The yellowish-white, shiny eggs (Fig. 12I) were collected under semi-fresh cow-pats during March. They measure  $1,1 \times 0,96$ – $1,8 \times 1,2$  mm, vary from nearly round to oval, and are without any significant sculpture.

The newly hatched nymphs (Fig. 12J) are 3.4 mm long (excluding the forceps) and almost white with pale brownish blotches, particularly on the abdomen. As in the two previously mentioned species, a white, longitudinal median line, representing the posterior part of the ecdysial suture, traverses the thorax. It is connected anteriorly to the so-called 'epicranial suture' of the head. The antennae are brownish and eight-segmented and the eyes brown. Most nymphs reached a length of 6 mm about 70 days after hatching.

Nymphs 8,7–10 mm long (including the forceps) collected during March, are darker in colour than newly hatched specimens. The antennae are fifteen-segmented, with the five apical segments much longer than the others, except the first and third segments. The eyes are almost black and the forceps measure about 2,3 mm.



In larger nymphs (16.6–17 mm long including the forceps) the colour remains the same, but the stripes on the abdomen are darker. The antennae are then twenty-segmented, the last ten segments being somewhat longer than the others, except the first and third segments, which are the longest. Wings are already partially developed and partly cover the first abdominal segment.

As in the other species, the forceps are used to crush the prey, which is then lifted over the body and devoured. The nymphs were found to feed on small scarabaeid larvae and for this purpose they often dug holes in the soil with their mandibles.

#### ORDER ORTHOPTERA

##### Family Gryllidae

Exopterygote hexapods with well-developed cerci, and short antennae with few segments to long and multi-segmented. Hind legs usually saltatorial, fore-legs often fossorial and in certain species with tympani. Wings well developed or absent. Usually omnivorous, but a few species are phytophagous, causing damage to crops and lawns: under certain circumstances they may even become predacious or cannibalistic. Some sphecids of the genera *Tachysphex*, *Liris*, *Chlorion*, and *Isodontia*, and probably also *Gasteroceriscus*, prey on crickets (Arnold 1922, 1923, 1928; Bohart & Menke 1976).

Of the somewhat thirty-five species of true crickets (family Gryllidae) that have been collected in southern Africa, only three were observed in decaying matter during the surveys, of which the common field cricket, *Gryllus bimaculatus* de Geer, was the most abundant and most widespread. It often shelters under stranded kelp on the intertidal zone and when reared in the laboratory occasionally accepted pieces of wrack, though it preferred fish-meal and grass cuttings. According to Smit (1964) it can be a pest of the vegetable and flower garden.

##### *Cophogryllus delalandi* Saussure

A wingless species (Fig. 13C–D). Ground colour pale creamy white to pale whitish yellow, with dark-brown marks on dorsal side of body. Cerci, antennae and ovipositor brownish; the ovipositor being 11–11.6 mm long in mature females (Fig. 13E). Body length of adult females collected along the west coast vary from 14.9 to 18.3 mm: males measure about 13.7 mm.

According to Chopard (1955) *C. delalandi* is widely distributed in the western and southern Cape Province and has been collected as far east as Mossel Bay. It was found to be a common prey of the baboon-spider (*Harpactira* sp.).

Adults were collected almost throughout the year along the west coast under stones and dry to semi-fresh cow-pats. During the summer and early winter large numbers were often observed, in some cases up to six gravid females under a single small pat. Eggs (Fig. 13F) were found under the sand under semi-dry pats during November. These measure from  $2,50 \times 0,74$  mm

to  $2,7 \times 0,91$  mm and are fairly dull (only slightly shiny), with a fine superficial reticulation and varying in colour from creamy white to a dirty brownish white. Females with eggs were also noticed during April. It was impossible to determine the incubation period of the eggs, but in a few cases eggs laid during July hatched only in November. Just before the young cricket emerges the two reddish eyes, the mandibles, and the segmentation of the body become visible through the chorion.

Nymphs that hatched during November (Fig. 13A) measured about 2,5 mm long and were almost pure white with dark brownish eyes. After about 4 hours they usually turned to a pale grey colour (Fig. 13B) and after about 11 days the colour became quite dark. A thin pale longitudinal line over the thorax represents the ecdysial suture and anteriorly joins the epicranial suture. The legs are pale except for a dark transverse band near the apices of the femora. As the nymph increases in size, its body becomes mottled with brown. The size increase in the laboratory over a period of about 140 days is shown graphically in Figure 13G. Although growth was fairly fast during the first 100 days (the nymphs reaching a length of about 10 mm in March) some specimens matured only during midwinter.

In the females examined, rudiments of the ovipositor appeared about 103 days after hatching and within 50 days had reached a length of nearly 4,6 mm. At this stage the nymphs are all found in small burrows in the loose sand and in the laboratory they have to be kept in separate jars to prevent predation. In field collections made during February large numbers of young females, 11–11,6 mm in length, were found, their ovipositors being only 1,8 mm long; in specimens collected during June the ovipositors had already reached a length of 5,5–6,1 mm.

#### *Cophogryllus* sp.

This species is also wingless and somewhat larger than *C. delalandi*, females (Fig. 14A) measuring from 16,6 to 20 mm in length are somewhat more robust. The body marked with dark-brown stripes instead of the mottled coloration of *C. delalandi* and ovipositor much longer, measuring 16,6–25,0 mm. Femora of hind legs pale yellowish to creamish and not marked with dark coloration.

This species is widespread in the Cape and has been observed even in the Great Karoo near Beaufort West. In the western Cape adults of this species were collected under dry cow-pats in sandy areas during the late summer to early winter, and eggs were collected in the sand under the pats during the latter part of January.

The eggs (Fig. 14C) are somewhat larger than those of *C. delalandi* and vary in size from  $2,8 \times 0,64$  to  $3,2 \times 0,96$  mm. They are yellowish to yellowish white in colour, shiny and without any form of sculpture. The incubation period is about 28 days and the newly emerged nymphs (Fig. 14B) are dirty white, almost transparent, with the last two abdominal segments and distal half of the cerci somewhat orange. The head in all the specimens examined is of a pale

golden yellow, the eyes reddish. Most first-stage nymphs measure from 3 to 3,2 mm. About 4 hours after hatching they become piceous, but have reddish eyes surrounded by a whitish margin; even the thirty-four-segmented antennae and the cerci are piceous except for the hair bases, which are white. The borders of the apical antennal segments also have an orange coloration. As in the previous species, the ecdysial suture forms a pale, longitudinal median line over the body and is anteriorly continuous with the epicranial stem. The hind femora are pale piceous, lacking a dark transverse band.

Characteristic of the nymphs of both this species and those of *C. delalandi*, are the long, blackish median hairs on the thorax and posterior borders of the abdominal segments. Nymphs of this species differ from those of *C. delalandi* in that they construct a little burrow soon after hatching, into which they then retreat. The burrow was in most cases extended for several millimetres along the surface, in a similar way to those made by golden moles.

The nymphs are usually very pale after each moult. In the specimens examined, the first moult occurred 9–10 days after the nymphs had hatched and most of them at this stage measured about 3,3 mm, with the antennae in almost all the specimens consisting of about forty-nine segments. After the first moult the nymph already resembles the adult fairly closely in colour. Further moults were observed at 44 and 45 days and again at 100 to 102 days after hatching. The first rudiments of the developing ovipositor appeared after 202 to 207 days. In larger nymphs (about 14 mm long) collected during November, the ovipositor was only about 3,3 mm in length. In specimens kept under observation in the laboratory, the ovipositor reached a length of 4,3 mm about 300 days after hatching. The increase in size of the nymphs over a period of 280 days, as observed in the laboratory, is shown graphically in Figure 13G.

#### *Gryllus bimaculatus* de Geer

In the common black field cricket the wings are well developed, with the hind wings pointed in both sexes and extending beyond apex of abdomen (Fig. 14E). Males are easily recognized by the venation of the front wings (Fig. 14F) and absence of an ovipositor; front wings pale fulvous in most specimens examined. The species differs from *Cophogryllus* spp. by the presence of a distinct tympanum (Fig. 14J) on both sides of the front tibiae (absent on both sides in *Cophogryllus* spp.—Fig. 14D). Wing bases pale yellow and broadly so in males, but narrower in the case of females. Three distinct ocelli, reddish in colour, are present.

Very often crickets with reduced hind legs are found. Crickets are aggressive and when nymphs lose a leg in a skirmish, it is replaced at the following moult by one that is smaller than usual.

This species is widely distributed in Asia and Europe and has been collected all over South Africa and Zimbabwe, including some of the islands along the west coast such as Bird Island near Lambert's Bay.

In the western Cape adults were observed under decaying kelp on the beach and under semi-fresh to dry cow-pats, both in the winter and summer, and eggs (Fig. 14I) were collected under semi-dry pats throughout the summer and autumn. In some cases batches of twenty eggs were laid in cracks in the pats, in others eggs were deposited in the top 4 or 5 mm of soil in batches of fifteen or more; in a few instances, however, eggs were laid singly in the sand. Those found near Philadelphia measure  $2,5 \times 0,56$ – $2,8 \times 0,76$  mm and are almost banana-shaped. The colour varies from a whitish yellow to almost golden yellow, the eggs being fairly shiny and without any form of sculpture.

As the embryo develops the egg becomes slightly darker and after a few days the body segmentation, the two black eyes, the apices of the mandibles, and the cerci become visible through the chorion; some eggs develop a dark ring at the anterior pole.

In the laboratory the incubation period was 8–15 days during January. Rivnay & Ziv (1963) gave the mean incubation period in Israel as 7,5 days (34 °C) to 75 days (16 °C).

The newly hatched nymphs are about 2,7 mm long and pale whitish, translucent, with blackish eyes; three ocelli are indicated by three black marks. They remain quiescent for 3–4 hours, after which they become piceous (Fig. 14G) with reddish eyes; they can then easily be distinguished from second instar nymphs and nymphs of the other two species by the white mesonotum and pale, almost white posterior half of the pronotum. The pale cerci are white at their bases, with piceous apices. As in the other species, there is a white, longitudinal median line over the back and the legs are also piceous. In the few specimens examined, the antennae consisted of thirty-four segments.

The first moult occurred 7–22 days after hatching in specimens that hatched during January–February and by this time they were about 4,9 mm long and black all over (including the pro- and mesonotum), except for the pale, median dorsal line, the brown eyes, pale brownish cerci, and the small whitish areas on the sides of the pro- and mesonotum. The antennae consisted of about forty-nine segments (Fig. 14H). A second moult occurred 40–48 days after hatching, the nymphs remaining more or less of the same colour as in the second instar. After each moult the colour is pale brownish white mottled with brownish, but they assume their normal black colour in 2,5–4 hours.

Development was fairly rapid in the laboratory during the first 100 days or so and most of the nymphs reached a length of 12,5–14 mm after 94–120 days, depending on the amount of food available. The size increase during the first 120 days is shown graphically in Figure 13G. The ovipositor appeared 37–52 days after hatching.

As already stated, adults were found throughout the year and large numbers of nymphs collected during September at Elands Bay reached maturity during that month. According to collection data it seems as if there was only one generation annually during the surveys with overlapping of the different stages.

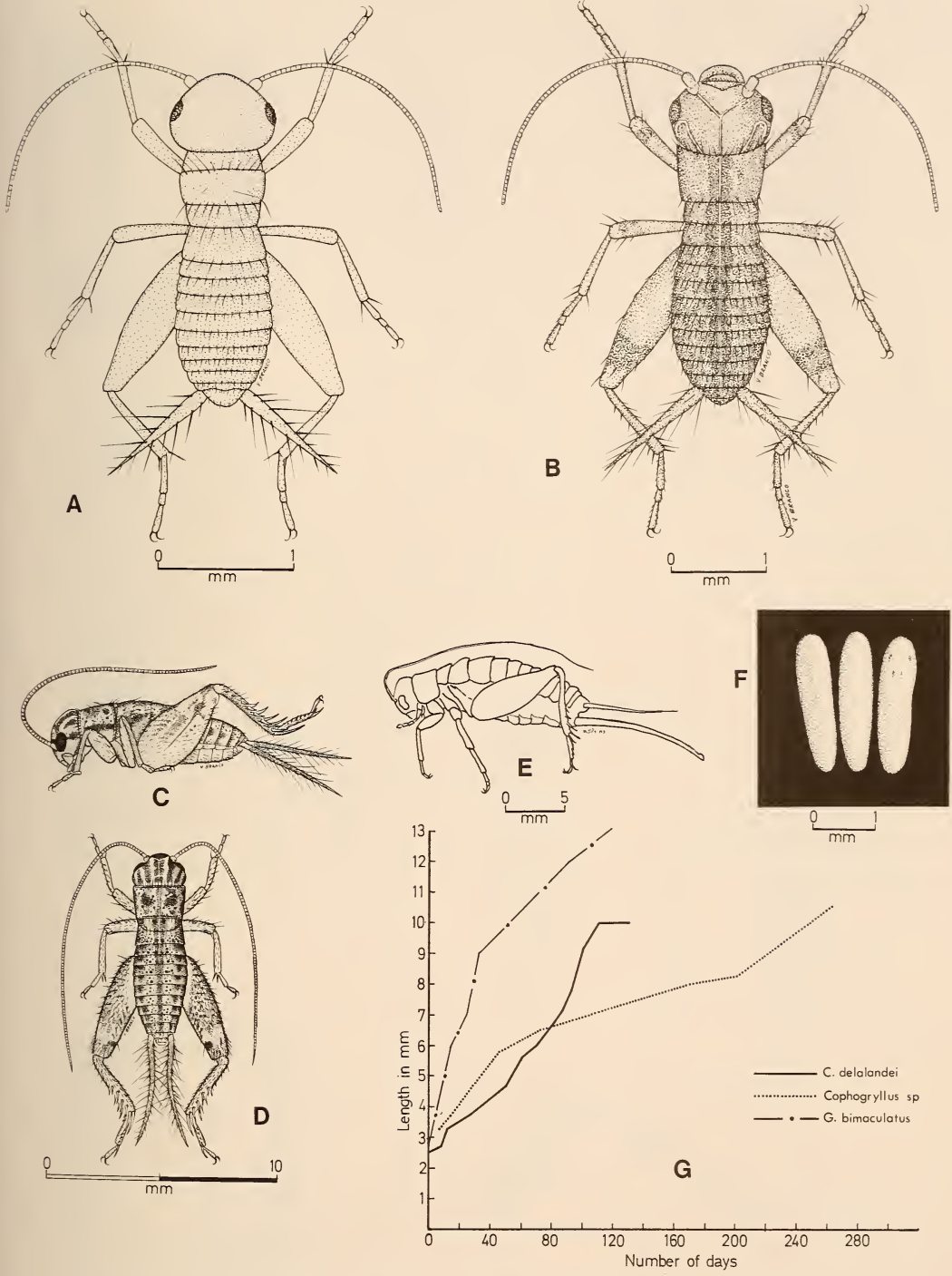


Fig. 13. A-F. *Cophogryllus delalandi*. A. Newly hatched nymph. B. Eleven-day-old nymph. C. Adult male (left lateral view). D. Adult male (dorsal view). E. Outline of adult female. F. Eggs. G. Size increase of *C. delalandei*, *Cophogryllus* sp., and *G. bimaculatus* as observed in the laboratory over a period of 140 to 300 days.

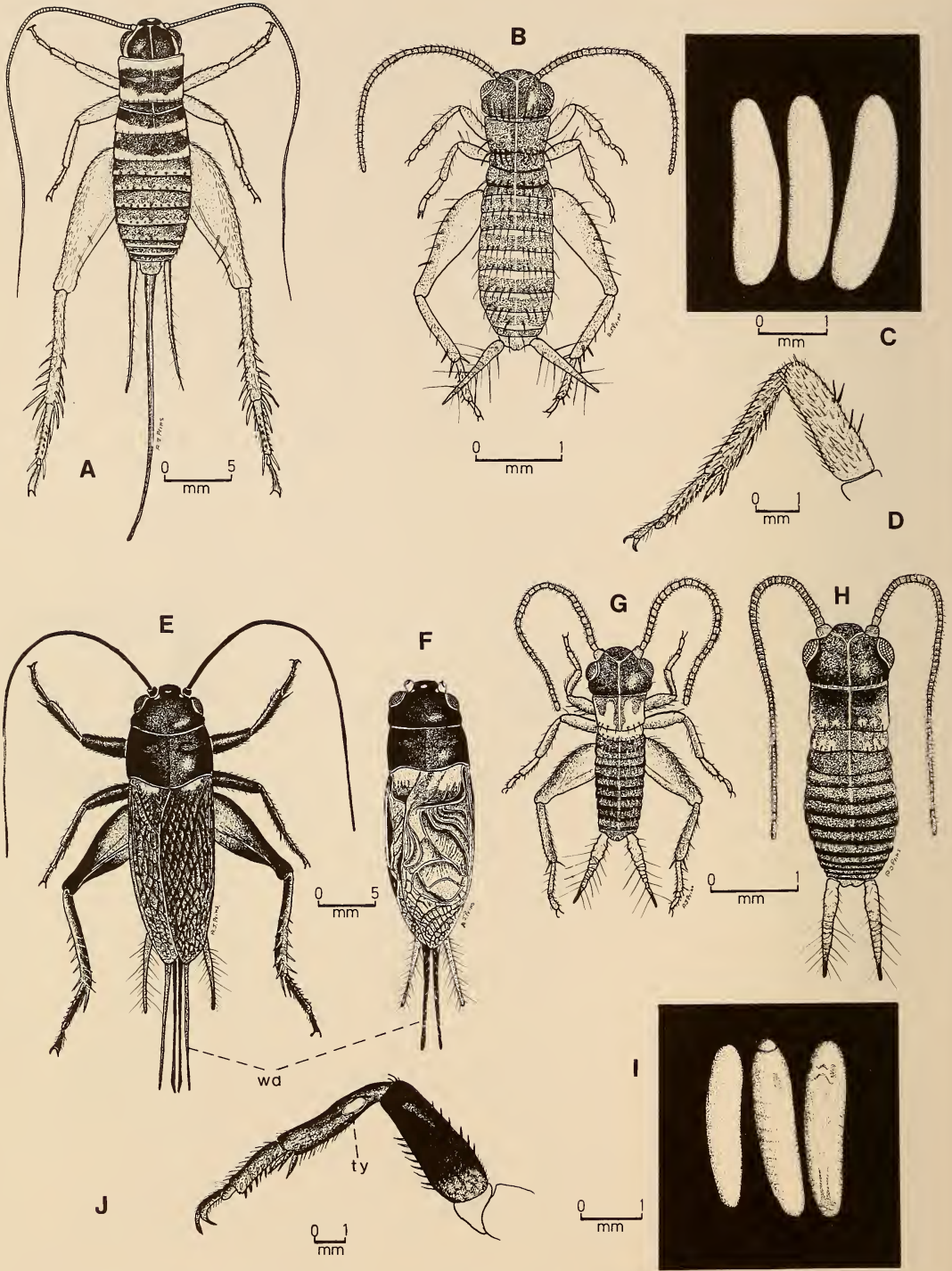


Fig. 14. A-D. *Cophogryllus* sp. A. Adult female. B. Newly hatched nymph. C. Eggs. D. Left foreleg (posterior view). E-J. *Gryllus bimaculatus*. E. Adult female showing pointed wing apices (wa). F. Adult male showing pointed wing apices. G. Newly hatched nymph. H. Second instar nymph. I. Eggs. Middle one showing black ring and body segmentation. Right one with developed embryo, showing cerci in lower pole. J. Left foreleg (posterior view showing tympanum (ty)).

A peak emergence of adults occurred during the spring and early summer months with an apparent second peak during the winter.

They were observed to feed on various substances including fish-meal, grass, and bran, and when they were confined to a small space they devoured each other; this was also found by Rivnay & Ziv (1963).

#### ORDER HEMIPTERA

#### Family **Anthocoridae**

Small, somewhat flattened, mostly predacious exopterygote hexapods with three-segmented rostrum and antennae with only a few segments. Cerci absent. Legs cursorial. Ocelli present.

#### Sp. indet.

The adults (Fig. 15K) vary from 2,8 mm to 4,2 mm and are dark brown with a lighter yellowish coloration on the hemelytra. Eyes scarlet and ocelli clearly visible. Legs with three-segmented tarsi, and antennae pale yellow.

This species was very common in the early dermatophagous stage of decay of certain animal carcasses around Cape Town and both adults and nymphs were found to feed on small fly larvae that were present, especially those of the blue-black carrion-fly *Ophyra capensis* (Wiedemann). It was also found in the Constantia area in poultry manure in which house-flies, false stable-flies, and the lesser house-fly were breeding.

Nymphs of all stages were collected during the period January to April. Those about 1,0 mm long (Fig. 15I) are pale brownish with scarlet eyes, cream-coloured abdomen and pale, almost translucent legs and antennae. Also three small, oval, reddish spots present on middle of abdomen, marking the openings of repugnatorial glands. Characteristic of these nymphs are two long setae on the apex of the abdomen; these are absent in the 1,4 mm long nymphs. Larger nymphs, about 2,1 mm long, are very similar to the smaller ones, but the colour is somewhat darker, especially on the abdomen, and the first two abdominal tergites are whitish in the middle.

In the 3,4 mm specimens (Fig. 15J) there is a clear, whitish-yellow, longitudinal, median line over the head and thorax, and wing rudiments are present. The six small, semicircular patches dorsally on the abdomen mark the openings of repugnatorial glands. The colour of these nymphs is yellowish with brownish patches.

All the immature stages have two-segmented tarsi and ocelli are indicated by two small scarlet patches in nymphs about 2,0 mm long and larger.

#### Family **Coreidae**

Rather similar to the Lygaeidae and also with four-segmented rostrum, but membrane of front wings with numerous branched veins. Ocelli present. All the species are phytophagous.

Very few squash bugs were associated with decaying organic matter when the surveys were made and, apart from the species discussed here, only the dull, greyish-brown *Stenocephalus testaceus* Stål, about 9,5 mm long, was found to shelter under dry cow-pats along the west coast. However, Payne *et al.* (1968) found three species in America, belonging to the genera *Megalotomus* and *Alydus*, actually feeding on pig carrion.

*Leptocoris hexophthalma* (Thunberg)

This species is pale crimson to crimson with brownish wings and measures 10–11,5 mm in length (Fig. 15H). It is widely distributed in the Cape, Natal, and the Transvaal and was also collected in east Africa. It is common in the Karoo and sometimes congregates in very large numbers on the debris beneath the bergvygie, *Drosanthemum* sp., and the skaapbossie, *Justicia orchioides*. Both newly hatched and mature nymphs have been collected on these plants during March, when they cause extensive damage to the foliage.

The nymphs of this species are quite different from those of the other Hemiptera inhabiting the same habitat, viz. *Melanostethus marginatus* (Thunberg), *Scantius forsteri* (Fabricius), and *Cenaeus carnifex* (Fabricius), as they are fairly hairy and the repugnatorial gland openings are small and inconspicuous. In small (2,0 mm) nymphs (Fig. 15F) the hairs are long, but in larger nymphs the hairs are short and almost spine-like. All stages of the nymphs are very similar except for the presence of wing rudiments in the later instars (Fig. 15G). Ocelli become visible subcutaneously only in nymphs larger than 7,0 mm; in adult forms the tarsi are three-segmented, as in most other Heteroptera.

Family Lygaeidae

Similar to Anthocoridae, but with four-segmented rostrum and membrane of front wings with only a few veins. Ocelli present. Apparently predominantly seed-feeding; however, a few species are predacious.

Masses of dying and dead stink-bugs, particularly the chinch-bugs *Microspilus proximus* (Dallas), *Geocoris scutellaris* Puton, and *Nysius binotatus* (Germar) (one of the crop pests, particularly crucifers), and the damsel-bug, *Nabis capsiformis* Germar (Nabidae), together with various other beetles such as coccinellids, tenebrionids and carabids, are often found in the intertidal zone along the west coast. This happens when these insects are blown out to sea by strong winds and are then washed on the beaches.

*Melanostethus marginatus* (Thunberg)

This species is 5,8–5,9 mm long, rather dull black, with two large reddish triangles on wings and clear circular spot on wing membrane (Fig. 16L). Heme-lytra covered with short silvery hairs, which are absent on disc of each clavus, thus forming an oval black spot. Pronotum deeply and abundantly pitted.



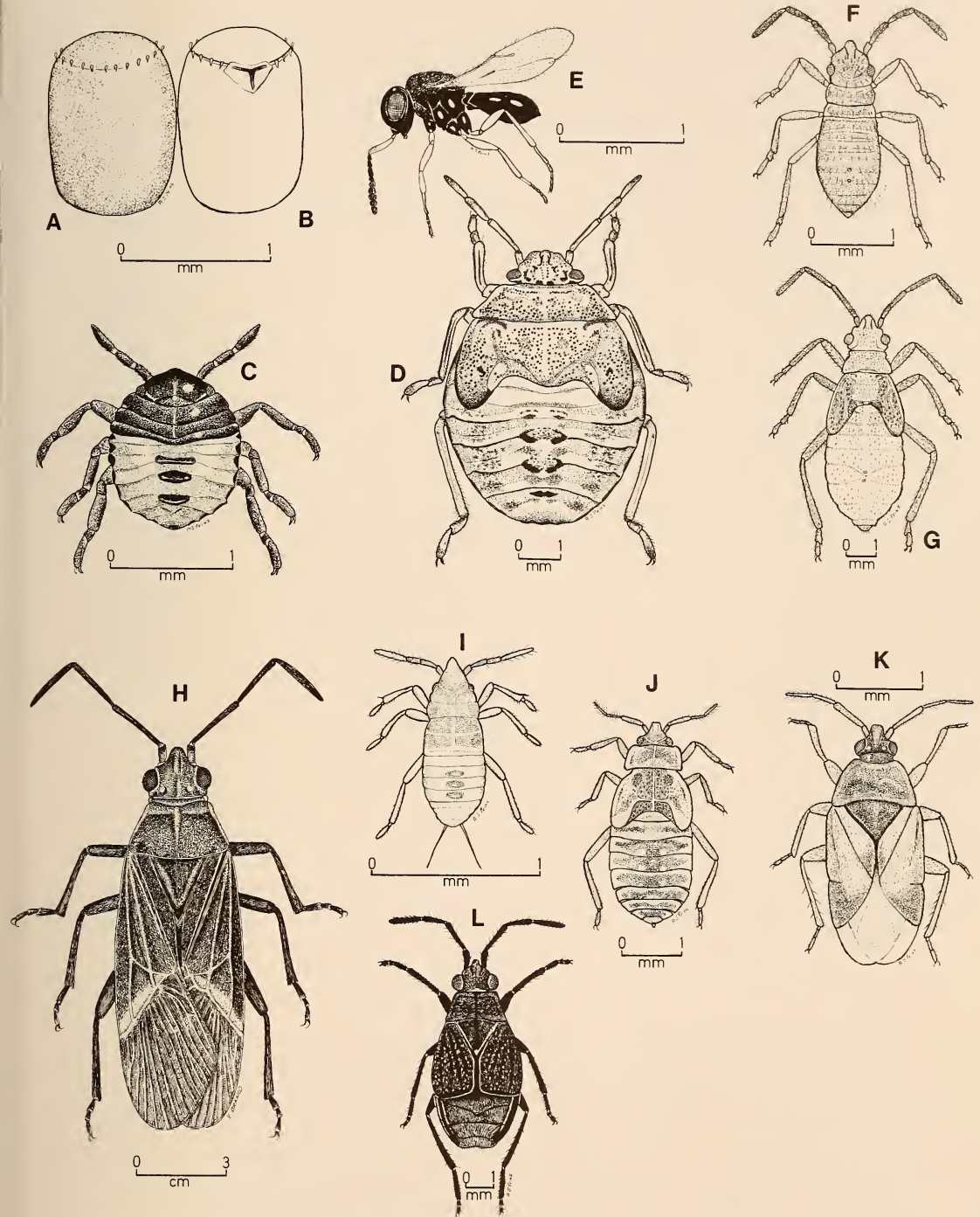


Fig. 15. A-D. *Antestiopsis orbitalis*. A. Egg. B. Egg from which nymph was hatched. C. Newly hatched nymph. D. Nearly mature nymph. E. *Telenomus* sp. (egg parasite of *A. orbitalis*). F-H. *Leptocoris hexophthalma*. F. Nymph measuring 2,0 mm. G. Nymph measuring 7,5 mm. H. Adult. I-K. Anthocoridae. I. Nymph measuring 1,0 mm. J. Nymph measuring 3,4 mm. K. Adult. L. *Aderrhis tartareus* (adult).

It is widely distributed in the Cape Province (Slater 1964) and the southern Orange Free State, and is a common feeder on *Arctotheca populifolia*, *Senecio elegans* (wild cineraria) and other plants, including *Clutia daphnoides*. It has also been found to feed on female Cantharidae. Nymphs are very often found among debris on the sand-dunes and large numbers of adult bugs have been collected under dry kelp strings on the beach.

As in the case of all other members of the family Lygaeidae, there are two ocelli in the adults and the tarsi are three-segmented (Fig. 16O). In the small nymphs (2,8 mm) (Fig. 16M), collected during April, the presence of the ocelli is indicated only by two dark brownish marks. In this stage the body is scarlet and the posterior corners and sides of the pronotum as well as the metanotum are pure white. There is a thin, yellowish, longitudinal line over the middle of the thorax; the eyes are brown. The two ostioles of the repugnatorial glands are indicated by two brown patches and the connexivum is marked with white on each segment. The femora are reddish marked with white on the bases and apices. The tibiae and tarsi are pale brownish. The first and last antennal segments are reddish, but the second is pale brownish, and the third whitish.

Larger nymphs (4,0 mm) (Fig. 16N), collected during December, are dark brownish red on the head and thorax, and the ecdysial suture is yellowish. The posterior margin of the pronotum is bordered by a white band, which is continued along the lateral margins; the white coloration of the metanotum is visible between the two wing rudiments. The antennae and the legs are the same colour as the body, except for the white apices of the femora and the terminal antennal segment, which is darker than the others. The two ostioles and extreme apex of abdomen are dark brown and the connexivum is almost the same colour as in the 2,8 mm long nymphs.

#### Family Pentatomidae

Easily recognized by the large scutellar area, rostrum also four-segmented. Most species are phytophagous such as the bagrada bug, green stink-bug, and the well-known antestia bug, which is a pest of coffee in the northern parts and a fruit pest in South Africa, and which will be very briefly discussed here. However, a few species are predacious, feeding mostly on the caterpillars of Lepidoptera.

#### *Antestiopsis orbitalis* (Westwood)

Specimens collected on the fore-dunes along the south and west coasts are pale cream to almost dirty white; some have orangy patches on the head, front margin of pronotum, scutellum, and along wing embolium. Eyes are brown. In some specimens there is an orange spot anterior to each eye, as well as two spots on the anterior part of the scutellum; in others these orange spots are completely absent. These bugs measure 6,9–7,5 mm in length. Greathead (1966) has given a good account of the different colour variations and the distribution.

They are widely distributed from the Cape to Kenya but, according to collecting data, they are absent from the Karoo. Eggs, nymphs, and full-grown specimens of this shield-bug were collected during the summer (December–February) on the foliage of *Arctotheca populifolia* along the coast. Brown patches on the leaves resulted where large numbers of the feeding stages were concentrated. They often congregate in large numbers on leaf litter under the above-mentioned plant.

The eggs of this species (Fig. 15A–B) are about 1.1 mm long and 0.9 mm wide, creamy white in colour, and the operculum is surrounded by a row of short micropylar processes; about twenty-seven were counted in most of the eggs collected. All the eggs found were laid in batches of twelve on the surface of leaves. After hatching, the black, T-shaped egg-burster can be seen on one side of the empty eggshell. The newly hatched, chocolate-brown nymphs (Fig. 15C), about 1.2 mm long, with two pale yellowish white patches on the pale abdomen, are apparently gregarious, at least up to the first moult, and were often seen clustered around the eggs during February. As the nymphs increase in size, they assume the coloration of the adult forms (Fig. 15D).

Skaife (1953) has given a short account of the life-history of this bug and Greathead (1966) has listed its food plants. According to Annecke & Moran (1982) it also damages the growth tips of *Protea* and *Leucadendron* species. An egg parasite, *Telenomus* sp. (Fig. 15E), has been recovered from the Strandfontein area near Muizenberg, Cape Province.

#### Family **Pyrhcoridae**

Similar to Lygaeidae, with membrane of front wings also with only a few veins, but ocelli absent. Usually brightly coloured with red, orange and black. Most of them are phytophagous and include the well-known cotton-stainers; however, a few are predacious.

#### *Scantius forsteri* (Fabricius)

The colour of this red bug (Fig. 16A) is dark chocolate-brown, but front of head, thorax, apex of scutellum, hemelytra, and connexivum are all marked with crimson. It is very variable in colour and in some specimens the hemelytra are uniformly chocolate-brown. The antennae and legs are dark chocolate-brown, almost black in some specimens. Brachyptery is common. Specimens collected vary from 7.5 to 10 mm in length.

It is widely distributed in Africa and very common along the western parts of the Cape Province where the surveys were made. Adults and nymphs often occur in large numbers during the summer and autumn under semi-fresh to dry cow-pats on the open beach and inland. It is also present on Dassen and Marcus islands.

The newly emerged, elongate nymphs (Fig. 16B) are pale piceous on the thorax and the head is pale brownish yellow with posterior border piceous. Eyes

scarlet, basal half of abdomen whitish flanked with scarlet and apical half yellowish white behind and scarlet in front; connexivum reddish; position of the repugnatorial glands indicated by three thin, transverse lines dorsally on apical half of abdomen. Legs pale piceous, first of the two tarsal segments and articulation points white. First two antennal segments pale brownish yellow, third and fourth pale piceous, with apical third of last segment white. Most of the specimens examined were about 1,6 mm long and in all of them minute denticles or spinules occur on the ventral side of the apices of the front femora.

As the nymphs increase in size (Fig. 16C), the ecdysial suture lengthens posteriorly over the first two to three abdominal terga and the wing rudiments enlarge (Fig. 16D). In the 10 mm newly moulted nymphs, the wings cover the greatest part of the abdomen and the tarsi are three-segmented. The whole insect is scarlet, except the wings and the largest part of the second antennal segment, which are almost white. Eyes are piceous. In older adults the colour is darker and the teeth on the apices of the femora are more strongly developed (Fig. 16E-G).

Along the south coast a dull, brownish-black brachypterous pyrrhocorid *Aderrhis tartareus* (Stål) (Fig. 15L) was fairly generally collected under dry cow-pats together with *Scantius*. It is 8-8,5 mm long, with a short, thin, orange-red, transverse band on the posterior border of the head and an orange-red spot on the apex of the scutellum. According to Stehlik (1965) it is found only in South Africa and seems to have predacious habits. A macropterous female, collected by R. W. Tucker in the Transvaal in December 1913, measured only 7,1 mm in length.

#### *Cenaeus carnifex* (Fabricius)

This species (Fig. 16H) is yellowish red, fairly dull or only slightly shiny; scutellum, frons and posterior border of head blackish. Antennae, proboscis and legs blackish, except for basal third of femora, which is reddish. The specimens examined measure 8,3-10,0 mm in length. Brachyptery is common. The genus is characterized by the crossed parameres (Stehlik 1965).

It is widely distributed in the Cape and Natal.

Nymphs and adults of *C. carnifex* were collected under dry cow-pats during midwinter. Adults are often seen on garden plants during the summer months. As in *Scantius*, all the immature stages have two-segmented tarsi, but the nymphs are quite different in other respects as they are more cicicoid in outline, paler in colour and the ostioles of the repugnatorial glands are represented by three larger blackish patches. In all the immature stages, as well as adults examined, spines are present only on the apices of the front femora (Fig. 16K).

In the 4,5-5 mm nymphs (Fig. 16I), the legs and antennae are piceous, the articulation points reddish. The head, except the median area, is yellowish and the thorax brown with yellowish ecdysial suture. The abdomen is pale yellowish red with a blackish apex.

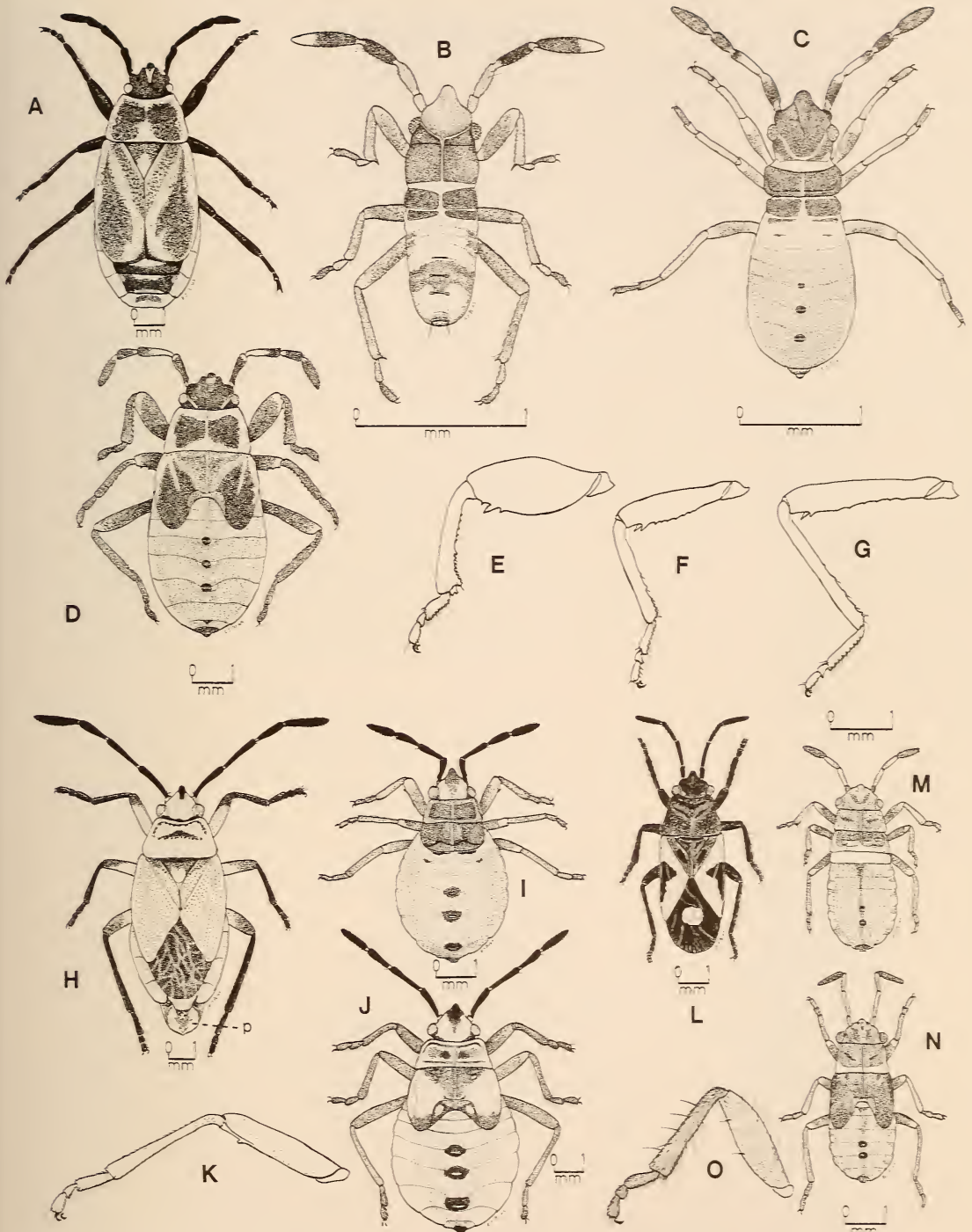


Fig. 16. A-G. *Scantius forsteri*. A. Adult. B. Newly hatched nymph. C. Nymph measuring 2.3 mm. D. Nymph measuring 6.4 mm. E. Prothoracic leg of male (posterior view). F. Mesothoracic leg of male (posterior view). G. Metathoracic leg of male (posterior view). H-K. *Cenaeus carnifex*. H. Adult showing crossed parameres (p). I. Nymph measuring 4.7 mm. J. Nymph measuring 7.8 mm. K. front leg (posterior view) showing spine on anterior ventral side. Enlarged to same scale as E-G. L-M. *Melanostethus marginatus*. L. Adult. M. Nymph measuring 2.8 mm. N. Nymph measuring 4.2 mm. O. Foreleg (posterior view).

Larger nymphs (6,5–8 mm) (Fig. 16J) are similar to the smaller ones, but rudiments of wings are present and most of the pronotum, except two darker areas on each side of the middle, is yellowish.

#### Family Reduviidae

Easily recognized by the strongly developed, curved, three-segmented rostrum. Wings usually well developed, though some species are apterous. Many species have raptorial front legs and many stridulate when handled, the stridulation being prolonged under certain conditions. Predacious, mainly feeding on arthropods. Most species inject a saliva containing a paralyzing agent, which also helps to digest the tissues. In man the bite causes severe pain; the tissues surrounding the puncture become inflamed and harden and the irritation can persist for several days. The subfamily Triatominae includes species that suck the blood of vertebrates and transmit disease-causing trypanosomes; however, none of these are known to occur in South Africa.

Certain assassin-bugs, particularly of the genus *Pirates*, are attracted to lights and are often found in houses. An unidentified black species (about 11 mm long) belonging to this genus as well as one shiny, metallic bluish-black, apterous *Glymmatophora* sp. (12–15 mm long) have on several occasions been reported to have bitten people in the western Cape, causing severe pain and swelling. Some assassin-bugs, including these two widely distributed species that have both been collected under cow-pats, bite without hesitation when carelessly handled or when pressed against the skin, and may cause severe symptoms in hypersensitive people.

Several assassin-bugs were found to shelter under semi-dry cow-pats, feeding on the smaller arthropods present. The most common of these is the hairy, black *Coranus carbonarius* (Stål) (Fig. 17H), which is 11–12,5 mm long. Blackish nymphs, with blackish-grey abdomen, found in the vicinity, probably belonged to this species. *Coranus pallescens* (Germar), a smaller, greyish bug (about 8 mm long) was found under similar conditions together with *C. papillosus* (Thunberg) (Fig. 17I), which is known to be a predator of codling moth larvae (Myburgh *et al.* 1973). *Coranus papillosus* is about 9,8 mm long, dark brownish grey in colour and very similar to *C. pallescens* (which was also found to be a victim of the black widow *Latrodectus mactans* (Hesse 1942)). It is well established on some of the islands along the south coast, e.g. Dyer Island.

A rather small, brownish *Didymocephalus braunsi* Bergroth (about 7,5 mm long), covered with fine velvety hairs as in the case of *Coranus* spp., was fairly numerous near Hermanus during winter, whereas a species of *Harpactor*, of about the same length as *C. papillosus* but almost black, the connexivum coloured black and yellowish white, was more common along the north-western parts of the coast. Specimens observed were found to feed on coleopterous larvae.

In the subfamily Holoptilinae the members attract their prey, which consists mainly of ants, by means of a special scent gland or trichome present on the

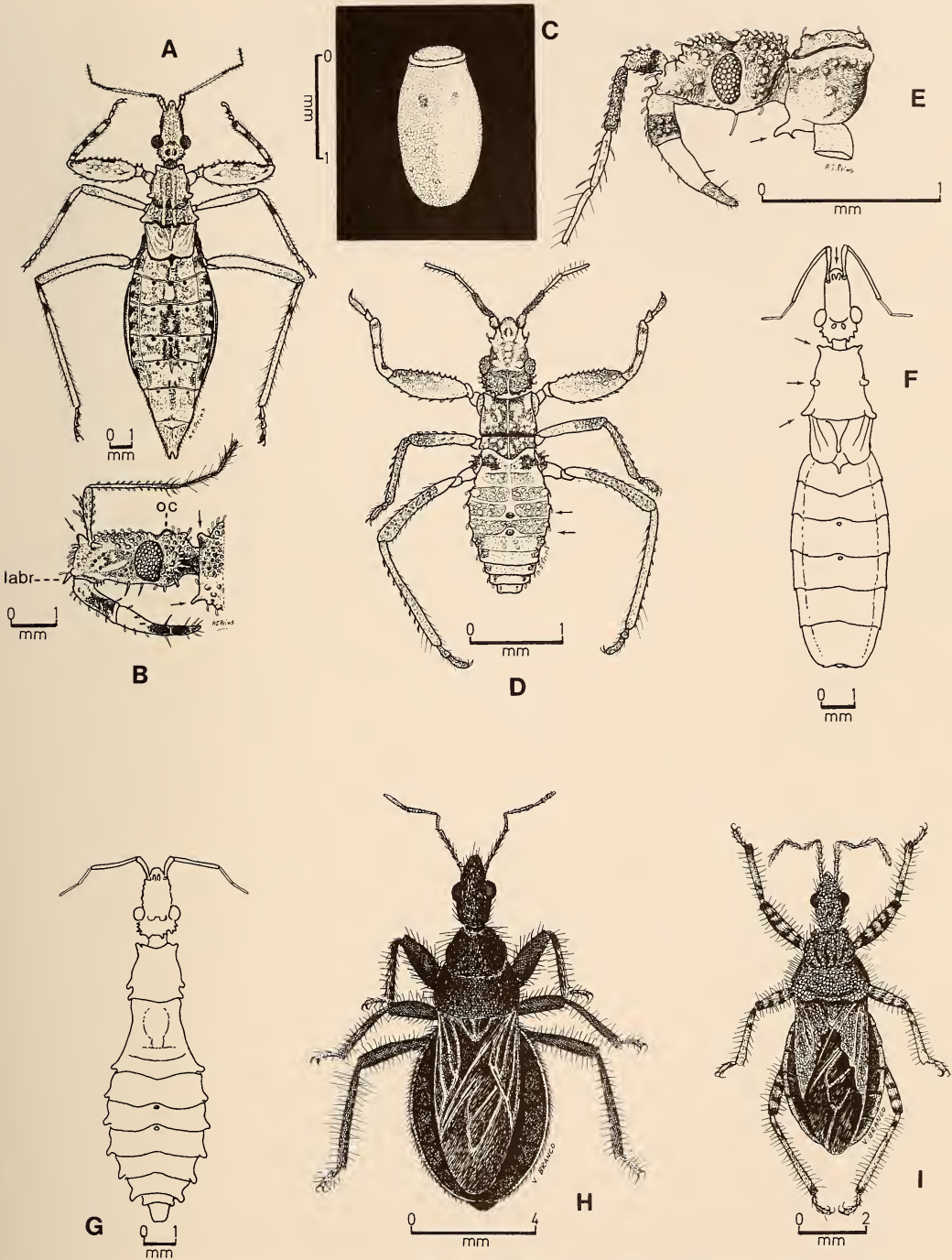


Fig. 17. A-G. *Oncocephalus* sp. A. Female (adult). B. Head of female showing labrum (labr) and ocelli (oc). C. Egg showing developing eyes of nymph. D. Newly hatched nymph. E. Head of newly hatched nymph. F. Outline of male. G. Nymph 11.6 mm long (outline of body), probably belonging to the second species. H. *Coranus carbonarius* (adult). I. *Coranus papillosus* (adult).

ventral surface of the abdomen. These bugs are sluggish and usually covered with long hairs. An unidentified species of *Holoptilus* was discovered in the nest galleries of the ant *Melissotarsus beccarii* Emery in the trunks of the pincushion *Leucospermum praemorsum* in the vicinity of Clanwilliam (Prins *et al.* 1975), the bugs living a 'double life' as symphile and predator. *Holoptilus ursus* le Peletier & Serville, a small brownish assassin-bug with a brown patch on the proximal half of the whitish hemelytra, is common on debris in sandy areas along the Cape south coast where it feeds on the smaller ants, particularly the minor workers of the pugnacious ant, *Anoplolepis steingroeveri* (Forel).

*Oncocephalus* sp.

The full-grown females (Fig. 17A) measure 18 mm in length and are cream coloured or greyish marked with piceous brown. Largest part of first segment of beak, apical half of second and whole of its third segment is piceous. Body, including legs, covered with fine tubercles, those on head and thorax being larger and tooth-like and each bearing a spatulate seta. Also present are some thickened hairs and fine whitish scale-like hairs that have the look of a pruinescence. Characteristic of most of the specimens examined are the two black dots on the median area of most of the abdominal segments and the tiny blackish ostioles of the repugnatorial glands on the anterior borders of the third and fourth visible terga.

Head (Fig. 17B) bears two rounded teeth between four-segmented antennae. Second antennal segment very long, about twice as long as first; apical and praepical segments of about equal length and together slightly more than half the length of the second. Labrum small and triangular. Pronotum with six teeth, four on anterior and two on posterior lobe. Also a fairly acute tooth present on each anteroventral corner of pronotum. Anterior lobe of pronotum fairly convex transversely and longitudinally.

Front femur swollen, its anteroventral margin bearing about twelve small teeth; front and middle tibiae clearly marked with two or three dark transverse bands. Wings atrophied in both females and males; latter similar to females but easily distinguished by rounded apex of abdomen (Fig. 17F); in females abdominal apex is pointed.

The specimens studied came from the Saldanha and Elands Bay areas along the west coast.

This is a rather slow-moving insect that feigns death when disturbed by extending its front and middle legs forward and its hind legs backward. The specimens were all collected under almost dry cow-pats during autumn and early winter. The eggs (Fig. 17C) are elongate with a convex operculum and have an almost matt, dirty yellowish-white colour and a very fine and superficial reticulation; they measure  $1,60 \times 0,96$  mm to  $1,80 \times 1,20$  mm. Eggs were laid under the sand under dry pats during July and August and the incubation period was at least 28 days in the laboratory (at 19 °C).



Newly hatched nymphs (Fig. 17D) measure about 2,55 mm in length and are pale brownish white, posterior half of head, pronotum and meso- and metanotum being darker. Eyes crimson. First two abdominal segments dark. Abdomen pale piceous or greyish and the two ostioles of repugnatorial glands already visible. A thin, white, longitudinal median line over the thorax represents the acdysial suture. Tubercles on body pale and each bears a spatulate seta. Legs pale and front femora already have teeth; hind femora somewhat darker.

These nymphs differ from the mature insects by the absence of both ocelli and rounded teeth between the antennae. Whole of second segment of beak is white (Fig. 17E). First and second antennal segments short; first only about half as long as second, latter about as long as third; apical and penultimate segments about equal in length. Head and pronotum much larger in relation to body than in adult, and dorsal teeth absent from thorax but anteroventral teeth fairly long. As in other Heteroptera the tarsi are two-segmented.

Development was very slow in the laboratory and after about 100 days they were only 3,6–4 mm long. Larger nymphs (about 5,1 mm long), collected during November, show the same characteristics as the newly hatched ones, but the thoracic teeth are more pronounced and each abdominal segment, except the first visible segment, has two pairs of small, oval, dark spots, the outer ones smaller; the connexivum also bears six dark spots on each side.

Fairly large nymphs, 11,6 mm long, collected during February, resemble the adults (including the presence of teeth between the antennae) but still possess abdominal spots (as in the 5 mm long nymphs).

The young nymphs unfortunately died of starvation in the laboratory, as they did not accept any prey offered to them.

From the specimens collected this is either a polymorphic species or possibly two species of similar coloration present in the same area, as some of the males have much longer wing stumps, the ocelli are absent, the scutellar tooth is much smaller and the abdomen is more pointed. Nymphs (probably belonging to males of this second form) measuring 11–12 mm long (Fig. 17G), found during February, have the connexivum sexdentate on each side and the abdomen more pointed than in the other form.

Nymphs of another unidentified species collected at Elands Bay during the late summer, more cimicoid in outline, with slightly darker coloration and measuring about 9,0 mm long, have longer developed wing-covers. In this case the body is covered with slightly longer hairs, which are simple on the abdomen and more rod-shaped on the head and thorax. Almost the whole of the rostrum is dark brown in colour, apical half being almost black; the third segment is much smaller in relation to the second than in the previously mentioned species. In younger nymphs (7,3 mm long and also with longer wing-covers) the pilosity, particularly of the head and thorax, consists of hamate setae. In all the specimens examined, ocelli and the rounded teeth between the antennae so characteristic of the adults and larger nymphs of the first mentioned species, are absent.

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